Materia Medica and Therapeutics

J. Mitchell Bruce M.D. Lond.

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MANUALS

FOR

STUDENTS OF MEDICINE.

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MATERIA MEDICA

AND

THERAPEUTICS:

AN

Introduction to the Rational Treatment of Disease.

BY

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1884.

To

RICHARD QUAIN, M.D., F.R.S.,

CHAIRMAN OF THE PHARMACOPŒIA COMMITTEE OF THE GENERAL
MEDICAL COUNCIL,
ETC., ETC.

THIS WORK IS DEDICATED,

IN ADMIRATION OF A LIFE SPENT IN THE INTERESTS OF

MEDICINE AND THE MEDICAL PROFESSION,

AND IN GRATEFUL ACKNOWLEDGMENT OF CONSTANT

PERSONAL KINDNESS

DURING A VALUED FRIENDSHIP OF

MANY YEARS.

PREFACE.

THIS book is chiefly therapeutical in its scope, and is intended to be a rational guide to the student and practitioner of medicine in the treatment of disease. At the same time the MATERIA MEDICA has not been sacrificed. On the contrary, it will be found to be set forth in detail by the adoption of a *natural* and concise arrangement, which presents the subject in such a form that it can be quickly appreciated and easily remembered. The author attaches importance to the plan which he has adopted in the description of the Special Therapeutics, and which consists in systematically tracing the physiological action and uses of the different drugs in their passage through the body, from their first contact with it locally until they are eliminated in the secretion. In the part of the manual devoted to General Therapeutics he has further departed from the ordinary arrangement, by discussing the actions and uses of remedies, not under the headings of artificial groups, but of the physiological systems of the body—digestion, respiration, etc., so as to conduct the student from facts with which he is familiar to the great principles of treatment. In using the book, the first year's student is recommended to confine his attention to the Materia Medica proper; and under the action and uses of the drugs, to read only the words printed in thick type.

The author gratefully acknowledges the valuable assistance which he has received in the preparation of the work from his friends Dr. Quain, Dr. Lauder Brunton, and Dr. Frederick Roberts; from his brother, Dr. William Bruce of Dingwall; from Mr. Woodhouse Braine, who kindly sketched the section on the use of anæsthetics; and especially from his friend and former class-assistant, Mr. A. C. N. Goldney, who has relieved him of much labour by superintending the pharmaceutical portions, drawing up lists, and compiling the index.

The many standard treatises on Materia Medica and Therapeutics in this and other countries have been freely consulted, especially Nothnagel and Rossbach's "Arzneimittellehre," Husemann's "Arzneimittellehre," the works of Wood and Bartholow, and the useful volumes of Squire and Martindale.

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MATERIA MEDICA AND THERAPEUTICS.

INTRODUCTION.

MATERIA MEDICA AND THERAPEUTICS relate to the use of drugs in the treatment of disease. The place which these subjects occupy in the Medical Sciences lies, therefore, between Chemistry, Botany, Anatomy, and Physiology on the one hand, and Medicine and Surgery on the other hand; whilst they stand side by side with Pathology, the other stepping-stone from the more purely scientific to the more strictly practical portions of professional education. The student will now be able to turn to account his acquaintance with chemistry and biology, and to appreciate the fact that these sciences are the true foundations of all professional knowledge; and when he has reached the end of the volume he may anticipate with some confidence a personal introduction to the treatment of disease.

Let us consider what subjects are comprised under the title, "Materia Medica and Therapeutics."

Materia medica.—This term is applied to the materials or substances used in medicine, their names, sources, physical characters, and chemical properties, the preparations made from them, and the doses in which they may be given.

Therapeutics relates to the treatment of disease, the word signifying healing, from θεραπεύω, *I attend, heal*, or *treat*. It includes, therefore, all that relates to the science and art of healing, not merely by the application of the materia medica to the treatment of disease, but by the use of remedial measures of every kind, including diet, climate, baths, clothing, nursing, and the numerous other means which may be combined to restore health, not the least important being surgical treatment, or surgical therapeutics. This definition is manifestly far too comprehensive for our present purpose, which is concerned only with medicinal therapeutics, *i.e.* the uses of the materia medica. When this subject is discussed under the head of each article of the materia medica, as it comes before us in natural order, it is known by the name of the **special therapeutics** of that article. Materia medica and special therapeutics will constitute the first part of the work.

When the numerous and complex facts of special therapeutics are collected and examined, certain great principles may be educed from them, unfortunately still very far from being perfect, but sufficient to furnish the ground-work for a science of **general therapeutics.** This portion of our subject will be considered in the concluding part of the work.

Certain other terms, variously related to the preceding, must here be defined :

Pharmacodynamics (*φάρμακον, a drug*, and *δύναμις, power*) is a convenient name for that part of our subject which relates to the action of drugs upon the healthy individual, that is, the **physiological action** of drugs. In the first part of this work the term "action" will simply be used to express the same meaning.

Pharmacology (*φάρμακον, a drug*, that is, either a medicine or a poison) is a term which has been employed in two senses. With the older writers in this country it is the science that relates to the chemical and physiological properties of drugs, their selection and preparation, the extraction of their active principles, and the combination of these with others. More recently pharmacology has come to be used in a wider sense, and to include the whole subject of materia medica and therapeutics, for which it is a short and convenient term.

Pharmacy is the name applied to the *art* which corresponds with the *science* of pharmacology, the art of making the preparations indicated or ordered by the pharmacologist, and of dispensing the combinations prescribed by the therapeutist. In such a work as the present, the details of pharmacy must be mainly omitted. They have to be learned practically in the dispensary or pharmaceutical laboratory, not by rote from a book.

The Pharmacopœia.—The number of drugs used from time immemorial is enormous, and comparatively few are now believed to be really useful. To separate the valuable *materiæ medicæ* from those supposed to be worthless, books have been published from time to time by the governments or medical authorities of different countries, which furnish an authoritative list of the drugs generally recognised and used by the profession, and the preparations made from them, which have thus become "officinal" or official. These books are known as pharmacopœias (*φάρμακον, a drug*, and *ποιέω, I make*). In this country we have the British Pharmacopœia, which provides us with a tolerably accurate list of the drugs and preparations in use at the time of its publication. But as pharmacology is a rapidly-advancing science, especially from the direction of chemistry and pharmacodynamics, and as opinion is very unsettled on the subject of therapeutics, the pharmacopœias of different countries differ greatly; and the pharmacopœia of any given country neither is accepted at the time of its publication as perfect in itself and to be followed as an article of faith, nor remains a correct representation of professional opinion for any great length of time. It is, however, an invaluable medium of communication between the physician and the pharmaceutical chemist, whom it furnishes with formulæ for a great variety of preparations of definite composition, and an immense amount of information respecting drugs which is necessary in combining these, or in devising fresh preparations.

Plan of the Materia Medica.—In the Pharmacopœia the materiæ medicæ and their preparations are arranged alphabetically for convenience of reference, but in a systematic treatise they must be discussed in natural order.

The following plan will be adopted in these pages:

PART I.—THE INORGANIC MATERIA MEDICA.

Group 1. Alkalies and Alkaline Earths.
„ 2. Metals.
„ 3. Metalloids.
„ 4. Acids.
„ 5. Water.
„ 6. Carbohydrates and other Carbon Compounds.

PART II.—THE ORGANIC MATERIA MEDICA.

Group 1. The Vegetable Kingdom.
„ 2. The Animal Kingdom.

Each article will be discussed under several distinct and definite headings, which are as follows: The *names* of the drug, in Latin and in English, its *chemical formula*, if any, and the *definition of its nature*; its *source*; its *characters*; its *composition*; its *doses*; and the *preparations* made from it.

A general reference must here be made to each of these headings.

Names, nature, and sources of drugs.—These are sufficiently indicated by the above plan in the case of the inorganic materia medica. It includes many of the chemical elements, and a great variety of compounds of the same.

Vegetable drugs are derived from entire plants, including fungi and lichens, stems (woods), green tops and twigs, roots and rhizomes, barks and leaves, buds, flowers, parts of flowers and flowering tops, fruits and seeds ; and various vegetable products, including fixed and volatile oils, resins, oleo-resins, balsams, gums, gum-resins, inspissated juices and secretions. The animal materia medica includes entire animals, portions of animals, and products yielded either during life or after death.

The methods for obtaining the drugs will generally be given, and must be learned by the student, who should repeat for himself as many as possible of the easier processes. Most of these are already familiar to him in chemistry, such as *solution*, *filtration*, *evaporation*, *crystallisation*, *precipitation*, *decantation*, *sublimation*, *distillation*, *destructive distillation*, *digestion*, and *washing*. A few specially pharmaceutical processes will, however, require to be defined :

Pulverisation, the powdering of drugs, is done on a large scale in powerful drug-mills. On a small scale it may be done by simple *trituration* (*triturare*, to pound), or powdering in the dry state ; by *levigation* (*levigare*, to make smooth or fine), or rubbing down with the aid of a little fluid, the resulting paste being afterwards dried ; or by *mediate pulverisation*, in which some very hard substance or medium is mixed with the drug, in order to break up its substance thoroughly. Powdered drugs necessarily require *sifting*.

Elutriation (*elutriare*, from *eluere*, to wash out) consists in diffusing an insoluble powder in water, allowing only the heavier part to settle, and decanting the fluid ; allowing this again to settle for a longer time, so as to deposit a second or finer size of powder, and again decanting; and repeating the operation indefinitely until an extreme degree of fineness has been reached.

Lixiviation (*lix*, a lye) is a process of washing an ash or crude mixture of solids, for the purpose of dissolving out the constituents in the form of a lye, or water impregnated with salts.

Maceration and *Percolation* are described under *Tincturæ* (page 15).

Characters.—This part of the description must be studied practically. Using the Manual as his guide, the student must examine specimens of drugs, and note respecting each article its *general appearance* to the eye, whether liquid, solid, crystalline, etc.; its *colour*, its *weight*, its *smell*, and its *taste* (if non-poisonous). If convenient, his examination of the drug should follow the pharmacopœial account farther, and include the determination of its *reaction;* of its *solubility* in water, alcohol, ether, oils, etc.; and of the *effects of heat* on its volatility, fusibility, etc. Other important chemical properties, bearing on its pharmaceutical applications, may have to be studied, especially its *incompatibility* with other drugs, which prevents their combination in preparations. Along with the characters, in many instances, certain *tests* are given, which introduce the student to the subject of

Impurities, and the methods of distinguishing substances so like each other as to be very readily confounded. Impurities may be the result of the imperfect selection, preservation, or preparation of drugs, including chemical decomposition of every kind; or of fraudulent adulteration. Similarity is, of course, a matter of accident, but may give rise to serious error.

The tests of purity applied to *inorganic* drugs are mainly such as are familiar to the student of chemistry; and to avoid constant repetition, the most common of them will be represented here once for all:

	Impurity.	*Detected by.*
1. Impurities derived from the sources of the drug, or formed in the process of manufacture and imperfectly removed.	Water.	Bibulous paper; dampness; loss of weight by heat.
	Organic matter.	Colour.
	Sulphuric acid.	White precipitate with $BaCl_2$.
	Hydrochloric acid.	White precipitate with $AgNO_3$.
	Phosphoric acid.	Yellow precipitate with $AgNO_3$, soluble in HNO_3 and in NH_4HO.
	Carbonic acid.	Precipitate with lime-water; effervesces with acids.
	Sulphurous acid.	Zinc and HCl yield H_2S.
	Nitric acid.	H_2SO_4 and $FeSO_4$ give a brown ring between the two fluids.
	Lime.	White precipitate with oxalate of ammonia or with CO_2.
	Arsenic.	Yellow precipitate with H_2S.
2. Impurities derived from the apparatus used.	Metals, especially lead, iron, and copper.	Precipitates with $(NH_4)_2S$, or H_2S; and special tests.
3. Insufficient strength.		Volumetric test
4. Fraudulent adulterations.	Various colored earths.	Non-volatility; insolubility in HNO_3.
	Cheap salts.	Various tests.
	Starch.	Blue colour with iodine.
	Sugar.	Evaporation; quantitative test.

In the case of *organic* drugs, impurities are chiefly to be detected by careful physical examination and special quantitative tests.

Composition.—The composition of the inorganic drugs is expressed by their name and formula. On the other hand, the organic drugs are frequently highly complex, the chief proximate principles being the following: Fixed oils, volatile oils, resins, oleo-resins, gums, gum-resins, balsams, pectin, alkaloids, acids, neutral substances, glucosides, starch, sugar, cellulose, albuminous substances, ferments, colouring matter, salts, and extractives. Some of these demand general consideration.

Fixed oils are extracted by expression (if possible, without the aid of heat) from the seeds or fruits of plants, or from animal tissues. They are composed of oleate, with palmitate and stearate of glyceryl; that is, are compounds of fatty acids (oleic, palmitic, and stearic, as well as of other, less common) with the radical glyceryl, C_3H_5. With caustic alkalies or metallic oxides, they form soaps, the metal displacing the glyceryl, which is hydrated, and becomes glycerine, $C_3H_5 3HO$.

Volatile Oils; Resins; Oleo-resins; Balsams.—Volatile oils are obtained by distillation from entire plants, flowers, fruits, or seeds. Most of them are colourless when pure, and highly aromatic. They consist of a liquid hydrocarbon or *elæopten*, generally isomeric or identical with terpene, the hydrocarbon of oil of turpentine, $C_{10}H_{16}$; and of an oxydised hydrocarbon, usually a solid body, or *stearopten*, like camphor, $C_{10}H_{16}O$. A few volatile oils contain sulphur and nitrogen. Further oxydation converts a portion of volatile oils into *resins*, solid, brittle, non-volatile bodies, and thus gives rise to *oleo-resins*, which can be broken up into their two constituents by distillation. Resins or oleo-resins yielding benzoic or cinnamic acids are called *balsams*.

Gums are exudations from the stems of plants. They consist of two rather complex carbohydrates, *arabin*, $C_{12}H_{22}O_{11}$, and *bassorin*, $C_{12}H_{20}O_{10}$, which play the part of acid radicals, and exist in gums as salts of magnesium and potassium. Arabin is soluble in water; bassorin is not soluble, but swells into a gelatinoid mass. *Pectin*, vegetable jelly, $C_{32}H_{40}O_{28}$, $4H_2O$, occurs in a few medicinal plants, and, like the *mucilage* yielded by several others, is allied to gum. *Gum-resins* are natural or artificial exudations from plants, containing various proportions of gums and resins, or more frequently of gums, resins, and volatile oils.

Alkaloids are active principles formed within plants, which resemble alkalies in turning red litmus-paper blue, and form salts with acids. As a rule, they are crystalline solids, rarely liquids; sparingly soluble in water, but readily in alcohol, the solution being intensely bitter.

Organic acids of great variety exist in plants, combined with the inorganic bases, such as potash and lime, with alkaloids, or possibly free.

Neutral substances are a very large and mixed group, including the carbohydrates, such as starch, sugars, gums, etc.; albuminous bodies, which occasionally act as ferments; a few bitter principles; and *glucosides.*

Glucosides are chiefly neutral bodies, capable of being decomposed in the presence of water into glucose and a second substance, different in each instance.

The remaining constituents of organic drugs do not call for special notice.

Dose.—The Pharmacopœia suggests the limits within which the different substances and their preparations may be safely given to an adult. These must be carefully learned. The principles of dosage will be presently discussed.

Preparations.—The list of preparations made from the drug, with the principal ingredients, strength, and doses of each, will conclude the account of its pharmacy. This subject demands special consideration here.

Most of the materiæ medicæ possess such characters that it is absolutely necessary to prepare them for administration. Thus, if we take, as examples, Sulphur, one of the elements; Potassii Iodidum, a crystalline salt; Chloroformum, a liquid compound of chlorine and formyl; Colocynthidis Pulpa, the dried pulp of a fruit; Jalapa, a tuber; and Cantharis, a dried beetle; it is manifest that few of these can be brought into useful contact with the body in their native form. Preparations must be made from them, and for several reasons we must have *a variety of preparations.* First, as we have just seen, substances are very various; secondly, a substance may contain several active principles, soluble in different media, which it may or may not be desirable to extract together or separately; thirdly, we constantly wish to obtain *combinations* of drugs, so as to increase, diminish, or otherwise modify the action of each, or to obtain combined action; fourthly, we must provide for variety of administration or application, externally or internally, to act on a part or to enter the blood by any of the methods of exhibition to be presently described; and we must be ready to meet the tastes and fancies of patients with respect to pills, powders, etc., as well as the necessities of circumstances.

The following is a list of the different kinds of preparations in the British Pharmacopœia. A complete list of each will be found in the synoptical tables at the end of the volume.

Aceta, Vinegars, are extractive solutions in acetic acid (not vinegar).

Aquæ, Waters, are very weak simple solutions of volatile oils in distilled water, obtained by distilling the vegetable products or the volatile oil. Aqua

Camphoræ is a solution without distillation. Aqua Chloroformi is the only aqua not made from an oil.

Cataplasmata, Poultices, are familiar external applications. They generally contain linseed meal as their basis.

Chartæ, Papers, consist of cartridge paper coated with an active compound much like a plaster.

Confectiones, Confections, conserves, or electuaries, are soft pasty-looking preparations, in which drugs, generally dry, are incorporated with syrup, sugar, or honey.

Decocta, Decoctions, are made by boiling vegetable substances in water from five to twenty minutes. All decoctions are simple, except that of aloes and one of the decoctions of sarsa.

Emplastra, Plasters, are external applications which adhere when applied to the body, and produce either a local or a general effect. The basis in all is a compound of fatty substances (resin, wax, lead, soap, etc.), and is intended to be spread on linen, leather, or other material.

Enemata, Enemas, injections, clysters, are liquid preparations for injection *per rectum.* The basis is generally mucilage of starch or water.

Essentiæ, Essences, are solutions of volatile oils in four parts of rectified spirit, *i.e.* are ten times the strength of the ordinary spirits.

Extracta, Extracts, are preparations obtained by evaporating either the expressed juice of fresh plants, or the soluble parts of dried drugs. They are, therefore, of several kinds :

1. *Green extracts.*—The juice pressed from the bruised plant is heated to 130°, to coagulate the green colouring matter, which is strained off and reserved. The fluid is next heated to 200°, to coagulate the albumen, which is separated by filtration and rejected. The filtrate is now evaporated at 140° to a syrup, the green

colouring matter returned, and the whole evaporated down to the required consistence. Ex.: Extractum Aconiti.

2. *Fresh extracts* are prepared like green extracts, but there being no colouring matter, the juice is heated at once to 212° Fahr. to coagulate the albumen, filtered, and evaporated at 160°. Ex.: Extractum Taraxaci.

3. *Aqueous extracts* are prepared from drugs by the action of cold, hot, or boiling water on dry drugs, and subsequent evaporation to a proper consistence. Ex.: Extractum Calumbæ, Extractum Gentianæ.

4. *Alcoholic extracts* are prepared by the action of rectified spirit, rectified spirit and water, or proof spirit on dry drugs, and evaporation to a proper consistence. Ex.: Extractum Physostigmatis.

5. *Ethereal extracts* are prepared in various ways; viz. (*a*) By percolating with ether and evaporating the product: Extractum Filicis Liquidum. (*b*) By making an alcoholic extract, macerating this in ether, and evaporating: Extractum Mezerei Æthereum. (*c*) By washing the drug free from oil, by percolation with ether, before making an aqueous or alcoholic extract: Extractum Ergotæ Liquidum.

6. *Acetic extract.*—The only extract of this kind, Extractum Colchici Aceticum, is made like a fresh extract, but acetic acid is added to the crushed corms before expression, and evaporation is arrested whilst the mass is soft.

7. *Liquid extracts* are prepared by macerating the drug in water, evaporating to form a concentrated solution, and adding a little spirit to prevent decomposition. Ex.: Extractum Pareiræ Liquidum. The process is modified in the case of ergot and filix mas, as described under ethereal extracts.

The consistence of extracts varies much. Some are liquid; four are solid, viz. those of aloes (2), hæmatoxylum, and krameria; five are soft, viz.

the acetic extract of colchicum, and the extracts of cannabis indica, mezereon, nux vomica, and physostigma; the rest are of the consistence suitable for forming pills.

Glycerina, Glycerines, are solutions of substances in glycerine. They are suitable either for further solution or for application locally.

Infusa, Infusions, are obtained by steeping vegetable substances in water, generally near the boiling point. The infusions of calumba and quassia are made with cold water; those of chiretta and cusparia with water at 120° Fahr. Those of orange and gentian are compound; that of roses contains acid.

Injectio Hypodermica, Hypodermic Injection, is a strong aqueous solution of an active drug for administration with a syringe and needle under the skin.

Linimenta, Liniments, or embrocations, are preparations suitable for application by rubbing, anointing, or painting. All liniments contain either camphor, oil, or soap.

Liquores, Solutions proper, consist of substances other than volatile oils dissolved in water; but the preparations of many are complicated, solution being assisted by spirit, acids, ether, lime, other salts, or carbonic acid as in the effervescing liquores.

Lotiones, Lotions, or washes, are solutions or mixtures for external use by washing or on lint. The British Pharmacopœia contains but two lotions, Lotio Hydrargyri Flava, and Lotio Hydrargyri Nigra.

Mellita, Honeys, are fluid preparations containing a large proportion of honey.

Misturæ, Mixtures, are made by rubbing up various substances in water, the product being not a solution, but a mixture only. The insoluble substances are generally suspended in the water by means of gum, spirit, or milk. They are frequently compound.

Mucilagines, Mucilages, are solutions of colloid substances in water.

Oleum, an Oil, is a solution in a fixed oil. Ex.: Oleum Phosphoratum.

Pilulæ, Pills, are soft easily divisible masses, variously composed of extracts or substances naturally tenacious, with suitable "excipients," such as treacle, confection of roses, or powdered liquorice. They are almost all complex. The substances best adapted for giving in pill form are such as are not conveniently given in fluid form, or those intended to act slowly.

Pulveres, Powders, are compounds of dry substances reduced to powder and intimately mixed.

Spiritus, Spirits, are either simple or complex. *Simple spirits* are solutions of colourless substances or oils in rectified spirit, the latter of the strength of 1 in 50. Ex.: Spiritus Chloroformi, Spiritus Cajuputi. *Complex spirits* are prepared in a special manner; *e.g.* Spiritus Ætheris Nitrosi.

Succi, Juices, are the expressed juices of the fresh plants, to which one-third of their volume of spirit has been added to preserve them. Limonis Succus, Rhamni Succus, and Mori Succus, are not preparations, but natural products.

Suppositoria, Suppositories, are solid conical bodies, composed of active ingredients and various mixtures of fats and wax, or starch and soap, adapted for introduction into the rectum, where they are intended to melt.

Syrupi, Syrups, are fluid preparations containing a large amount of sugar.

Tincturæ, Tinctures, are solutions in spirit, either alone or combined with other solvents. They may be grouped according to (1) the *solvent*, (2) the *process*, or (3) the *ingredients*.

1. *Solvents.*—Rectified spirit is chiefly used when the substances contain resin or volatile oil, as in cannabis

indica. Proof spirit is adapted when the substances are partly soluble in water, partly in spirit, as in most tinctures. Ammonia is employed in the ammoniated tinctures of opium, valerian, quinine, and guaiacum; spirit of ether in Tinctura Lobeliæ Ætherea; and tincture of orange in Tinctura Quiniæ.

2. *Processes.*—(*a*) *Simple solution* or mixture. Ex.: Tinctura Ferri Perchloridi. (*b*) *Maceration.* Macerate the drug in the spirit for seven days; press, if necessary; strain; and add sufficient spirit to make one pint. Ex.: Tinctura Opii. (*c*) *Percolation.* Pour the spirit on the drug packed in a percolator, and add spirit slowly until one pint is collected. Ex.: Tinctura Zingiberis Fortior. (*d*) *Maceration and percolation.* Macerate the drug for forty-eight hours in part of the spirit; then percolate, adding more spirit as required; press, filter the products, mix the liquids, and add spirit to one pint. Ex.: Tinctura Digitalis.

3. *Ingredients.*—Tinctures are either simple, or compound, *i.e.* contain more than one active substance. Ex: Tinctura Benzoini Composita.

Trochisci, Lozenges, are dried tablets of sugar, gum, mucilage, water, and one or more active ingredients, uniformly divided or previously dissolved.

Unguenta, Ointments, are mixtures of active substances with lard, benzoated lard, suet, wax, or oil, variously combined; or with simple ointment. The ingredients are either thoroughly mixed or melted together.

Vapores, Inhalations, are preparations administered in the form of vapour or gas, disengaged on the union of the ingredients.

Vina, Wines, are solutions of drugs either in sherry (ex.: Vinum Ipecacuanhæ), or in orange wine (ex.: Vinum Quiniæ).

The following kinds of preparations are in common use, but are not ordered in the British Pharmacopœia:

Collyria, Eye-washes.

Gargarismata, Gargles, liquid preparations for application to the fauces.

Linctus, Linctuses, thin confections to be slowly swallowed in small doses to affect the throat.

Pessi, Pessaries, a small variety of suppositories for administration *per vaginam.*

Weights and Measures: Signs and Symbols.

The **weights** of the British Pharmacopœia are the grain, *granum;* the ounce, *uncia;* and the pound, *librum;* with their conventional symbols, gr., ℥, and lb., respectively.

The **apothecaries' scale** runs thus:

1 grain = *granum,* gr. i.;
437·5 grains = 1 ounce = *uncia,* ℥j.;
16 ounces = 1 pound = *librum,* lb.i.

It is very common, however, although not officinal, to employ a weight between the grain and the ounce, for the sake of convenience, called the *drachm,* ʒ, to signify 60 grains; not, let it be observed, the $\frac{1}{8}$th part of an ounce, as in the fluid measures.

A 20-grain weight, called the *scruple,* ℈, was formerly in general use, but is now mostly discarded.

Measures.—The measures of the British Pharmacopœia and their symbols are the minim, *minimum,* min., or ♏; the fluid drachm, *drachma fluida,* fl.dr., or *f*ʒ; the fluid ounce, *uncia fluida,* fl.oz., or *f*℥; the pint, *octarium,* O; and the gallon, *congius,* C.

The scale is:

1 minim = min.j., ♏ j.
60 minims = 1 fluid drachm, fl.dr.j., *f*ʒj.
8 fluid drachms = 1 fluid ounce, fl.oz.j., *f*℥j.
20 fluid ounces = 1 pint, O j.
8 pints = 1 gallon, C j.

Relations of Weights to Measures.—

1 minim	is the measure of	0·91 grain of water.
1 fluid drachm	„ „	54·68 „ „
1 fluid ounce	„ „	1 ounce, or 437·5 grains of water.
1 pint	„ „	1·25 lbs., or 8750·0 „ „
1 gallon	„ „	10 lbs., or 70000·0 „ „

Metrical system.—The metrical or decimal system of weights and measures, which is officinal on the continent of Europe, may possibly come to be adopted in this country, as being in many respects preferable to the other:

Weight.	1 milligramme	= the thousandth part of 1 gramme	= 0·001 grm
	1 centigramme	= the hundredth „ „	= 0·01 „
	1 decigramme	= the tenth „ „	= 0·1 „
	1 gramme	= weight of 1 cubic centimetre of water at 4°C.	
	1 decagramme	= ten grammes	= 10·0 grm.
	1 hectogramme	= one hundred grammes	= 100·0 „
	1 kilogramme	= one thousand „	= 1000·0 „

Capacity.	1 millilitre	= 1 cub. centim.	= the measure of	1 grm. of water.	
	1 centilitre	= 10 „	= „	10 „	
	1 decilitre	= 100 „	= „	100 „	
	1 litre	= 1000 „	= „	1000 „	(1 kilo.)

Relation of the weights of the British Pharmacopœia to the metrical weights.—

1 pound = 453·5925 grammes.
1 ounce = 28·3495 „
1 grain = 0·0648 „

and conversely:

1 milligramme = 0·015432 grain.
1 centigramme = 0·15432 „
1 decigramme = 1·5432 „
1 gramme = 15·432 „
1 kilogramme = 2 lbs. 3 oz., 119·8 gr. = 15432·348 gr.

Relation of the measures of the two systems to each other.—

1 gallon = 4·543487 litres.
1 pint = 0·567936 „ = 567·936 c. centim.
1 fluid ounce = 0·028396 „ = 28·396 „

1 fluid drachm = 0·003549 litre = 3·549 c. centim.
1 minim = 0·000059 „ = 0·059 „

and conversely :

1 cubic centimetre = 15·432 grain measures.
1 litre = 1 pint 15 oz. 2 drs. 11 min. = 15432·348 „

Domestic measures.—A teaspoonful is a convenient but not quite accurate measure of 1 fluid drachm ; a dessert-spoonful, of 2 fluid drachms ; a table-spoonful, of half a fluid ounce ; a wineglassful, of 1½ to 2 fluid ounces ; a teacupful, of 5 fluid ounces ; a breakfastcupful, of 8 fluid ounces ; a tumblerful, of 10 to 12 fluid ounces. Wherever accuracy is desired, a graduated measure glass must be used. Some "drops" being twice as large as others, it is specially dangerous to order drops of powerful remedies for children.

Action and uses of drugs.—The preceding subjects complete the information furnished by the Pharmacopœia ; but the student must next make himself acquainted with the action and uses of each drug, that is, its pharmacodynamical and therapeutical relations. In the following pages this portion of the subject will be discussed under four distinct heads, according to the order in which the drug affects the different parts of the body. These are as follows :

1. Immediate local action.—When a medicine is applied to an exposed surface, it may produce some effect or "act upon" it. This may occur either *externally*, *i.e.* on the skin or exposed mucous surfaces, such as the conjunctiva, anterior nares, vagina, etc. ; or *internally*—on the alimentary canal, especially the stomach and intestines, including the rectum. Some drugs have no further action.

2. Action in or on the blood.—The great majority of active remedies are absorbed into the blood, and enter into the composition of its plasma, much less frequently of the red or white corpuscles; that is, have an effect *in* it, but little or no effect *on* it. The student must carefully note the fact, that very few medicines produce their characteristic effect by acting upon the blood.

3. **Specific action.**—Leaving the circulation, drugs enter the tissues and organs, alter the anatomical and physiological state of one or more of them, and are then said to have a *specific* action upon these. In most instances this is the characteristic and most important part of the action of the drug.

4. **Remote local action.**—Medicinal substances, having passed through the tissues, are finally cast out of the body by the excreting organs, whether in the same form as they were admitted, or as the products of decomposition in the system. The kidneys are the great channel of escape for drugs; the lungs ("breath"), skin, bowels, mouth, mammary gland, and all mucous surfaces and wounds, to a less extent. Whilst thus passing through the excreting organs, the active principles of drugs frequently exert a further or remote local effect upon them, not infrequently resembling their immediate local influence.

Prescribing.—When the practitioner desires to employ drugs for the purposes of treatment, he turns to his knowledge of the action and uses of the materia medica, selects his remedies, and proceeds to order one or more of them, according to a recognised form or formula, which is called a *prescription.* This is a very difficult proceeding when first attempted, being nothing less than a serious and probably sudden practical test of one's acquaintance with an enormous subject. The beginner should know, therefore, what points are specially to be kept before him under these circumstances. Briefly, they may be said to be the following:

1. **Selection of the remedy.**—This is, of course, the first and fundamental proceeding of all. It is

intended to be the rational result of as accurate a knowledge as can be gained of the disease which has to be remedied, and of the means at our command of doing so. How this choice is to be made will be discussed under General Therapeutics in the third part of the work.

Idiosyncrasy.—Before finally deciding, however, on certain drugs, idiosyncracy must not be forgotten; that is, the peculiar susceptibility of some individuals to the action of particular medicines, such as opium, mercury, quinine, essential oils, and ipecacuanha. In almost every instance such idiosyncrasy means *increased* susceptibility; unpleasant or even dangerous results following an ordinary or even minute dose. It is well, therefore, before ordering such drugs, to enquire whether the patient has taken them previously, and if not, to use them cautiously at first.

2. **Selection of the preparation.**—The drug having been selected, the particular preparation of it will be selected in accordance with the considerations discussed under the head of varieties of preparations. The Pharmacopœia affords abundant choice, according to the channel by which it is to be administered. This naturally leads us to consider the

MODES OF ADMINISTRATION OF DRUGS.

(*a*) By the *skin*, or mucous membrane continuous with the skin, whether simply applied or rubbed in (liniment, ointment); painted on (pigment); worn on the skin (as a plaster); applied in a state of fine division by fumigation, with or without sweating; used as a gargle, injection, or wash; or insufflated on to a part. The effect desired is usually local only, but it may be general, many drugs being absorbed by the skin.

(*b*) By the *mouth*, to act locally on the alimentary canal, and to be absorbed from it, especially from the stomach.

(*c*) By the *rectum* (or *vagina* in the female), in the form of enema or injection (fluid), or of a suppository (solid). Sometimes drugs cannot be administered by the mouth, either on account of some physical obstacle, repugnance on the part of the patient, or irritability of the stomach; or to spare the strength generally, and the stomach especially, in conditions of exhaustion. Again, the action desired may be a local one on the rectum and pelvic organs, *e.g.* to relieve pain, destroy worms, or soften retained fæces.

(*d*) By injection under the skin—*subcutaneous* or *hypodermic injection*, or into the tissues—*interstitial injection:* excellent methods of admitting some remedies into the system with certainty and despatch, and in small bulk.

(*e*) By *application to wounds* or diseased surfaces, as lotions, poultices, gargles, injections, collyria; or by the *endermic* method, *i.e.* by being sprinkled on a blistered surface.

(*f*) By *inhalation*, the substances being sometimes volatile, and intended either to enter the blood through the pulmonary capillaries, *e.g.* chloroform, or to act directly on the parts to which they gain access in the form of smoke, *e.g.* cigarettes, powders, etc.; sometimes medicated watery vapours, such as Vapor Conii.

(*g*) By *intravenous injection*, very rarely practised in man.

3. **The Dose.**—The Pharmacopœia indicates the limits of ordinary doses, the minimum being the smallest useful dose which it may be wise to begin with, and the maximum being the largest usually given without special reason and caution. Experience alone can teach the practitioner how far he may safely and wisely depart from these limits, to which he is in no wise tied by law. Several modifying circumstances which are to be taken into account with respect to doses must here be carefully noted.

(*a*) Many drugs have *different actions in different doses*, which must be arranged accordingly; *e.g.* antimonium tartaratum, alcohol, opium, and rhubarb.

(*b*) The dose must vary with the *age* of the patient, children getting but a fraction of a dose for an adult. A convenient method of calculating the doses for children under twelve, is to divide the age in years by the age in years + 12, and to use the result as the proper fraction of an adult dose. Thus, for a child of four years the dose will be $\frac{4}{4+12} = \frac{4}{16} = \frac{1}{4}$ of an adult dose; for a child of twelve, $\frac{12}{12+12} = \frac{12}{24} = \frac{1}{2}$. Above twelve, and under twenty-one, the dose must lie between $\frac{1}{2}$ and a full dose. Delicate persons and patients exhausted by disease resemble children in bearing but small doses.

(*c*) In particular *diseases* the ordinary dose may have to be modified. In disease of the kidneys, where excretion is diminished, drugs which are discharged by this channel, such as morphia, are retained in the blood for a longer time, *i.e.* in larger quantity at any given time after administration, and symptoms of poisoning very readily supervene. Quite a different matter is the effect of a disease in neutralising the effect of a drug given to combat it. Thus, large doses of morphia will be tolerated in severe pain, because the action of the morphia is spent in overcoming the pain. The periods of menstruation, pregnancy, and lactation also require to be considered in prescribing.

4. **Frequency.**—Medicines are ordered to be taken one or more times, according to the desired end. Thus purgatives are generally taken in a single dose; an emetic is to be taken once, and repeated only in case vomiting is not induced; whilst tonics are generally ordered three times a day continuously.

5. **Duration.**—The period for which a drug may be given depends entirely on a variety of circumstances

which need not be discussed here. We must refer, however, to *accumulation*, *toleration*, *custom*, and *habit*. When a drug is allowed to enter the system at short intervals, for a sufficient period, more rapidly than it can be excreted, a time will obviously come when it will have *accumulated* so much in the tissues as to produce its effects in a marked degree. Powerful drugs, *e.g.* strychnia and digitalis, may thus begin to act as poisons after having been given in the same doses with benefit for weeks. On the other hand, certain drugs lose their effect when given for a length of time, from some cause still obscure, *e.g.* opium. The dose must then be steadily increased, *toleration* being said to be established by *custom*. If a patient become dependent on a drug, crave for it, and indulge in it to an unfortunate or even vicious extent, he is said to have developed a *habit* for that drug, such as the opium and alcohol habits or the habitual use of enemata.

6. **Time.**—The times of the day or night at which the doses must be taken are of the first importance; and speaking generally, it may be said that every advantage must be taken in this respect of the natural tendency which it is desired to assist or stimulate by the drug. Thus, drugs which induce sleep are naturally given at bedtime; alkaline stomachics before meals; saline purgatives early in the morning. The time required by the drug to act must also be calculated, especially in the case of the different purgatives.

7. **Combinations: Chemical and Physiological Incompatibles.**—In most instances more than one drug has to be given at the same time, and the practitioner finds that he must combine them in a single prescription, whether, for instance, pill, powder, or liniment. Successful combination is at once the most important and difficult part of the art of prescribing. Whilst it affords the prescriber an opportunity of applying the whole of his knowledge of

drugs and their action, it cannot be accomplished without a thorough acquaintance with the physical, chemical, and physiological properties of the ingredients of the proposed compound. The mere appearance, taste, and flavour of a mixture are important points to be considered in ordering it. The chemical reactions which may occur between the constituents must be constantly kept in view. The prescriber may either intend the constituents to remain chemically unchanged, or arrange for the decomposition of one or more of them, and the production of a new substance. Drugs which decompose each other are said to be *chemically incompatible* in the widest sense; but the use of the term is commonly restricted to instances in which the result is an unexpected, inelegant, useless, or dangerous compound. Thus, if it be desired to give a patient chlorate of potash and hydrochloric acid, we say that the undiluted acid is incompatible with the salt, because chlorine is produced by their combination; but if it be intended to order a fresh solution of chlorine in water, and the decomposition is deliberately planned, the combination would not be considered incompatible. A list of incompatibles will be found under the "characters" of the principal drugs.

The prime consideration, however, will be the physiological effect of the combination. This is very different in different cases. Each of the constituents may be intended to produce an effect different from the others; or to have the same effect; or one or more ingredients may be introduced to modify the action of the principal, that is, to correct some unpleasant, dangerous, or otherwise undesirable influence which it happens to possess, in addition to the influence which we wish to secure. Such *correctives* are necessarily physiological antagonists, and appear, therefore, to be physiological incompatibles; but it is for this very reason that they are to be combined, because whilst they neutralise the action of each other in certain directions, they are left mutually free to affect other parts of the system. Thus, calomel combined with opium prevents it from causing constipation, whilst it does not interfere with its action on the brain; and the opium, in turn, prevents the calomel from purging the patient, whilst it allows the mercurial to act as an alterative. Most purgative pills contain correctives or carminatives, which moderate the violence of peristalsis and prevent pain.

8. **The Prescription.**—A prescription consists of five parts: The *superscription*, consisting of a single sign, ℞, an abbreviation for *recipe*, "take"; the *inscription*, or body of the prescription, containing the names and quantities of the drugs ordered; the *subscription*, or directions to the dispenser; the *signature*, or directions to the patient, headed by *Signa;* and, lastly, the patient's name, the date, and the prescriber's name or initials. In what may be called a classical prescription, it was customary to arrange the constituents of the inscription under four heads, viz. the *basis*, or active drug proper; the *adjuvant*, or substance intended to assist, and especially to hasten, the action of the basis; the *corrective*, to limit or otherwise modify the same (commonly a carminative); and the *vehicle*, or *excipient*, to bring the whole into a convenient, pleasant form for administration.

To take an example:

Superscription.	℞
Inscription.	Ferri et Ammoniæ Citratis, gr.v. (*basis*). Liquoris Ammoniæ Fortioris min.jss. (*adjuvant*). Spiritûs Myristicæ, min.vj. (*corrective*). Infusi Calumbæ, ad ℥i. (*vehicle* or *excipient*).
Subscription.	Misce. Mitte doses tales viij.
Signature.	Signa—Two tablespoonfuls twice a day.
Patient's name.	Practitioner's name
Date.	or initials.

It will be seen that the first three parts of the prescription are in Latin; the signature or directions to the patient in English. The names of the drugs or preparations are in the genitive case, the quantities standing in the accusative case, governed by *recipe:*

Recipe, Spiritûs Myristicæ, minima sex.

Take, of Spirit of Nutmeg, six minims.

A few *abbreviations* and *signs* are allowed, viz.: ℞ for recipe; *m.*, misce; *S.*, signa; $\overline{aa}$., ana (*ανὰ*), of each; *ft.*, fiat, make; *q.s.*, quantum sufficit, a sufficiency; *ad*, up to, to amount to (the full phrase being *quantum sufficit ad*); $\bar{c}$., cum, with; *no.*, numerus, number; *p.r.n.*, pro re natâ, as required, occasionally; *rep.*, repetatur, let it be repeated; *ss.*, *ſs.*, semi, or semis, a half.

The names of drugs must always be written in full wherever there can be the smallest possibility of error. It is not only inelegant, but dangerous, to use such abbreviations as *Acid. Hydroc. Dil.*, and *Hyd. Chlor.*

The various weights and measures are expressed by characters and figures, very rarely by words, placed distinctly at the end of the line occupied by the name of each ingredient; but if two or more consecutive ingredients are ordered in equal quantity, it is usual, instead of repeating this each time, to write it only once after the last of them, preceded by the sign $\overline{aa}$, of each.

Part I.

THE
INORGANIC MATERIA MEDICA.

GROUP I.

THE ALKALIES AND ALKALINE EARTHS.

Of the alkalies and alkaline earths, potassium, sodium, ammonium, lithium, calcium, magnesium, and barium are used in medicine. These, together with their many salts, alone constitute a large proportion of the inorganic materia medica. Whilst each of them is so important as to require separate consideration, many facts connected with their action and uses are common to the whole group, and much that is said under the head of Potassium, the first of the series, will not require to be repeated under the others.

POTASSIUM. K. 39.

The salts and preparations of potassium are most conveniently discussed in the following order :

1. Potassæ Carbonas.—Carbonate of Potash, K_2CO_3, with about 16 per cent. of water of crystallisation.

Source.—Obtained from wood ashes by lixiviation, evaporation, and crystallisation.

Characters.—A white crystalline, very deliquescent powder, of caustic alkaline taste. 20 gr. neutralise 17 gr. of citric acid, or 18 gr. of tartaric acid.

Impurities.—Sulphates and chlorides.

Dose.—10 to 30 gr.

From Potassæ Carbonas are made:

a. **Potassæ Bicarbonas.**—Bicarbonate of Potash. $KHCO_3$.

Source.—Made from a solution of the Carbonate in distilled water, by passing a stream of carbonic acid gas through it, and purifying the crystals which form.

Characters.—Colourless right rhombic prisms, not deliquescent; of a saline, feebly alkaline taste; not corrosive. 20 gr. neutralise 14 gr. of citric acid, or 15 gr. of tartaric acid.

Dose.—10 to 40 gr.

Preparation.

Liquor Potassæ Effervescens. Potash Water. —Potassæ Bicarbonas, 30 gr.; Water, 1 pint. Dissolve, and pass into the solution as much CO_2 as it will contain under a pressure of 7 atmospheres.

Dose.—Ad libitum.

b. **Liquor Potassæ.**—Solution of Potash, KHO, (5·84 per cent.) in water.

Source.—Made from a solution of the Carbonate, by boiling with Slaked Lime and purifying. $K_2CO_3 + CaO,H_2O = 2KHO + CaCO_3$.

Characters.—A clear alkaline fluid.

Impurities.—Lime, carbonates, sulphates, and chlorides.

Dose.—15 to 60 min.

From Liquor Potassæ are made:

a. **Potassa Caustica.**—Caustic potash. KHO.

Source.—Made from Liquor Potassæ by evaporation.

Characters.—White pencils, hard but very deliquescent, alkaline and corrosive.

Impurities.—The same as of the liquor.

From Potassa Caustica is made:

Potassæ Permanganas. — Permanganate of potash. $KMnO_4$. See *Manganesium.*

Source.—Prepared from a mixture of caustic potash, chlorate of potash, and black oxide of manganese, by semi-fusing; then boiling, neutralising with dilute sulphuric acid, and purifying. (1) $KClO_3 + 6KHO + 3MnO_2 = 3K_2MnO_4 + KCl + 3H_2O$. (2) Boiling: $3K_2MnO_4 + 2H_2O = 2KMnO_4 + 4KHO + MnO_2$.

Characters.—Dark-purple slender prisms, inodorous, with a sweet astringent taste. Soluble in 16 parts of cold water. Should be prescribed in simple solution.

Impurities.—Sulphate of potash and oxide of manganese; detected by less solubility in water and volumetric test.

Dose.—1 to 2 gr.

Preparation.

Liquor Potassæ Permanganatis.—4 gr. in 1 fl.oz. of distilled water. *Dose,* 2 to 4 fl.dr.

β. **Potassii Iodidum.**—Iodide of Potassium. KI.

Source. — Obtained by dissolving Iodine in Liquor Potassæ, and evaporating—$6KHO + 3I_2 = 5KI + KIO_3 + 3H_2O$; then mixing the residue with wood charcoal, fusing, dissolving, and purifying, to convert the iodate, which was formed with the iodide, into iodide—$2KIO_3 + 6C = 2KI + 6CO$.

Characters.—Colourless opaque cubical crystals, with some odour of iodine, a saline taste, and feebly alkaline reaction; strikes blue with preparations containing starch on addition of chlorine.

Impurities.—Iodate; detected by blue colour with tartaric acid and starch. Free iodine; by starch. And the impurities of the liquor.

Dose.—2 to 10 gr., or more.

For *Preparations,* see *Iodum.*

γ. **Potassii Bromidum.** — Bromide of Potassium. KBr.

Source.—Obtained from Liquor Potassæ, Bromine, and Charcoal, by the same process as the iodide.

Characters.—Colourless cubic crystals, without odour, and of a pungent saline taste. Does not strike blue with preparations containing starch, unless it contain iodide as impurity.

Dose.—5 to 30 gr.

c. **Potassæ Citras.**—Citrate of Potash. $K_3C_6H_5O_7$.

Source.—Made by neutralising a solution of Citric Acid with Carbonate of Potash, and evaporating. $3K_2CO_3 + 2C_6H_5O_7, H_3 = 2K_3C_6H_5O_7 + 3H_2O + 3CO_2$.

Characters.—A white deliquescent powder, of saline, feebly acid taste.

Dose.—20 to 60 gr.

d. **Potassæ Acetas.**—Acetate of Potash. $KC_2H_3O_2$.

Source.—Made by dissolving Carbonate of Potash in Acetic Acid, evaporating, and fusing the residue. $K_2CO_3 + 2(HC_2H_3O_2) = 2(KC_2H_3O_2) + H_2O + CO_2$.

Characters.—White foliaceous satiny masses, very deliquescent; neutral. The peculiar appearance of this salt is due to crystallisation after fusion.

Impurities.—The carbonate; detected by being insoluble in spirit. Excess of acid; giving acid reaction. Metallic impurities.

Dose.—10 to 60 gr.

Potassæ Acetas is used in preparing:

Tinctura Ferri Acetatis. See *Ferrum.*

e. **Potassæ Chloras.**—Chlorate of Potash. $KClO_3$.

Source.—Made by passing Chlorine gas into a mixture of Carbonate of Potash and Slaked Lime (*i.e.* caustic potash), boiling, evaporating, and separating the chloride of potassium by re-crystallisation. $6KHO + 6Cl = KClO_3 + 5KCl + 3H_2O$.

Characters. — Colourless rhomboidal crystalline plates, with a cool, sharp, saline taste. Explodes when rubbed with sulphur. Soluble in 16 parts of cold water.

Impurities.—Chloride of calcium, and lime.

Dose.—10 to 30 gr.

Preparation.

Trochisci Potassæ Chloratis.—5 gr. in each.

f. **Potassa Sulphurata.**—Sulphurated Potash.

Source.—Made by fusing together Carbonate of Potash and Sublimed Sulphur.

Characters.—Solid greenish masses, liver-brown when recently broken, alkaline and acrid to the taste: a mixture of sulphide, sulphate, sulphite, and hyposulphite.

Dose.—3 to 8 gr.

Preparation.

Unguentum Potassæ Sulphuratæ.—1 in 15½.

2. Potassæ Tartras Acida.—Acid Tartrate of Potash, Bitartrate of Potash, Cream of Tartar. $KHC_4H_4O_6$.

Source.—Prepared from argol, the deposit in wine-casks.

Characters.—A white gritty powder, or fragments of cakes, of a pleasant acid taste; not deliquescent. Soluble in 200 parts of cold water.

Dose.—20 to 60 gr. as a diuretic and refrigerant; 2 to 8 dr. as a purgative.

Acid Tartrate of Potash is an important ingredient of:

Confectio Sulphuris (1 in 9); and Pulvis Jalapæ Compositus (9 in 15). It is also used in preparing various other drugs.

From this salt is derived:

Potassæ Tartras.—Tartrate of Potash. $K_2C_4H_4O_6$.

Source.—Made by adding Acid Tartrate of Potash to a solution of Carbonate of Potash, and crystallising. $2KHC_4H_4O_6 + K_2CO_3 = 2K_2C_4H_4O_6 + CO_2 + H_2O$.

Characters.—Small colourless deliquescent prisms. 10 parts are dissolved in 8 parts of water.

Impurities.—Acid tartrate; detected by insolubility. Carbonates; by quantitative test.

Dose.—20 to 60 gr. as a diuretic and antacid; 2 to 4 dr. as a purgative.

3. Potassæ Nitras.—Nitrate of Potash, Nitre, Saltpetre. KNO_3.

Source.—Found native, and purified by crystallisation.

Characters.—Striated colourless prisms, of a peculiar saline taste. Solubility, 1 in 4 of water.

Dose.—10 to 30 gr.

From Potassæ Nitras is made:

Potassæ Sulphas.—Sulphate of Potash. K_2SO_4.

Source.—Prepared from Nitrate of Potash and Sulphuric Acid, which yield the acid sulphate—$KNO_3 + H_2SO_4 = KHSO_4 + HNO_3$; then adding Carbonate of Potash—$2KHSO_4 + K_2CO_3 = 2K_2SO_4 + H_2O + CO_2$.

Characters.—Colourless hard six-sided prisms, terminated by six-sided pyramids. Solubility, 1 in 10 of water; not soluble in spirit.

Impurities.—Other sulphates, and chlorides.

Dose.—15 to 60 gr.

Potassæ Sulphas is contained in:

Pulvis Ipecacuanhæ Compositus.—8 in 10; Pilula Colocynthidis Composita; and Pilula Colocynthidis cum Hyoscyamo.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Potash, in the form of potassa caustica, is a powerful irritant and **caustic**, absorbing water from the part to which it is applied, and converting it into a moist, grey slough. It is used to destroy morbid growths, to form issues, and to stimulate ulcers. Solutions of liquor potassæ or the carbonates neutralise caustic acids on the skin. Hot dilute solutions relieve the pains of rheumatism and gout when used as local baths or fomentations to the affected joints. Weak compounds of potash with olive oil constitute soft soaps, which also have **antacid** and cleansing properties.

Internally.—Potash and its salts have an alkaline action, and are employed as **antidotes** to the caustic acids; but the use of the carbonates for this purpose ought, if possible, to be avoided, on account of the great development of carbonic acid. In the mouth, potash checks for a moment the secretion of saliva. Reaching the stomach, it partly neutralises the contents; and liquor potassæ effervescens will relieve acidity due to excess of gastric juice, or to the decomposition attending indigestion. Of much greater importance is the **stomachic** action of potash given shortly before meals, when, as a dilute alkali, it is a natural stimulant to the gastric follicles, increasing the flow of the juice, and is a sedative to the nerves. Liquor potassæ and bicarbonate may be used for this purpose in dyspepsia, especially when there is much pain and tendency to sickness, or when the further action of potash on the system is desired, as in gouty, rheumatic, and calculous subjects; but soda is more commonly employed. Large doses of the bicarbonate are apt to irritate the stomach.

Some valuable **saline purgatives** belong to the potash group, notably the acid tartrate, tartrate, and sulphate. The rationale of the action of saline purgatives is discussed in Part III. In dropsy from any cause, especially ascites from liver disease, the acid tartrate, in the form of Pulvis Jalapæ Compositus, of an electuary with honey, or of a lemonade, may be used to remove the water by the bowels, its **hydragogue** effect being assisted by its action as a diuretic.

2. ACTION ON THE BLOOD AND ITS USES.

Potash is freely absorbed into the blood in the form of salts, and there acts both on the plasma and red corpuscles, increasing the natural alkalinity of the former, and improving the quality and increasing the number of the latter when judiciously combined with iron. As an **alkaliniser** of the plasma, although exceedingly transitory in its action, being very rapidly excreted, potash is a valuable remedy in gout, where it combines with the excess of uric acid in the blood and facilitates its excretion. The carbonates, citrates, and tartrates of potash in various forms, and the waters of such spas as Baden-Baden, Wiesbaden, Vichy, Carlsbad, and Aix-la-Chapelle, which contain definite though small quantities of potassium salts, are extensively used for the treatment of acute and chronic gout. The salts of the vegetable acids, or the effervescing carbonates, are the best preparations for prolonged use. In acute rheumatism the bicarbonate, citrate, tartrate, and acetate are successfully employed to increase the alkalinity of the blood. For restoration of the red corpuscles in anæmia by the increase of their potash element, the carbonate is the best **hæmatinic,** either as contained in the Mistura Ferri Composita, or given as a pill with sulphate of iron (Blaud's Pill).

An indirect action of potash on the blood must here be carefully noted. We shall see hereafter that citric, tartaric, and acetic acids, given internally, are partially oxydised in the blood. The completeness of the combustion, and of the important influences which the change exerts on the blood and kidneys, depends upon the combination of the vegetable acid with an alkali. Citric acid, *e.g.*, is excreted mostly unchanged in the urine, but citrate of potash is entirely, or almost entirely, thrown out as the carbonate.

3. SPECIFIC ACTION AND USES.

Potash **depresses** the **muscular, nervous,** and **cardiac tissues**; and the point of interest in this connection is, that when given for other purposes it must be used with caution. The danger of "potash poisoning" is, however, exaggerated, for the drug passes so quickly through the system, that it cannot well produce a deleterious effect on the tissues, unless given for a very long time, or in disease of the excreting organs, especially the kidneys. Excessive single doses are generally rejected at once by vomiting.

4. REMOTE LOCAL ACTION AND USES.

Potash is excreted almost entirely by the kidneys; to a much less extent by the skin, respiratory passages, stomach, liver, biliary passages, and bowels. In other words, it passes out in the fluids of all the secretory surfaces, and in doing so it stimulates the cells to increased activity.

The **diuretic** effect of several potash salts, referable to their influence upon the renal epithelium, is the most important of all; and the acetate, acid tartrate, citrate and tartrate, carbonate, bicarbonate, and sulphate are used for this purpose in the order named. These saline diuretics are given chiefly in renal dropsy, where it is desirable to increase the functional activity of the renal epithelium, and thus the secretion both of water and urea, whilst the vessels remain undisturbed. They are also suitable diuretics in feverish conditions. In cardiac dropsy they are less beneficial, as they diminish rather than increase the force of the circulation; but in an occasional full dose they are useful adjuvants, even in this condition, to other classes of diuretics, such as digitalis and scoparium, to wash out the tubules. Nitrate of potash is a powerful diuretic, belonging partly to a different class, the local vascular stimulants. It is more suitably employed as a diuretic in feverish conditions, and to remove inflammatory effusions into the pleura and pericardium, and must be given with caution in renal disease.

As **alkalinisers of the urine**, the carbonate, bicarbonate, and the vegetable salts of potash are extensively used in uric acid gravel, acute and chronic gout, and acute rheumatism, the latter being preferred because less irritant. In uric acid calculus of the kidney or bladder, these salts have been successfully employed to cause actual solution of the concretions.

The **diaphoretic** effect of potash salts is not marked, the citrate and the nitrate alone being used for this purpose, and that only in mild feverish attacks.

The bronchial secretions may be increased and rendered less tenacious in inflammation and dry catarrh of the tubes by the potash salts, which are thus saline **expectorants**, the iodide in particular being useful for this purpose.

Gastric catarrh, especially in gouty subjects, is benefited by the milder salts of potash beyond their immediate local effect; but the mineral waters which appear to act in this way, such as those of Vals, Vichy, and Carlsbad, owe their efficiency much more to soda. The same remarks apply to catarrh of the *biliary* passages and tendency to gall-stones.

The action of potash on the *intestinal glands* constitutes it a remote as well as an immediate purgative.

ACTION AND USES OF THE DIFFERENT SALTS OF POTASH.

On reviewing what has been said respecting potash, we find that the chief actions and uses of its different salts may thus be briefly represented: *Potassa Caustica*—caustic. *Liquor Potassæ*—antacid and stomachic. *Potassæ Bicarbonas, Carbonas,* and *Citras*—antacid stomachics, alkalinisers of blood and urine, mild diuretics, very mild diaphoretics, saline expectorants, biliary stimulants. *Potassæ Tartras, Tartras Acida,* and *Acetas* —the same, but more powerful diuretics; also saline purgatives. *Potassæ Sulphas*—chiefly purgative. *Potassæ Nitras* —excreted unchanged in the urine; is a double diuretic, and probably in this way only a mild febrifuge. *Potassæ Chloras*—excreted unchanged in all the secretions, including the saliva; and is much used in inflamed, ulcerative, and aphthous states of the mouth. The remaining salts of potassium contain, in combination with the alkali, an element or acid possessing such distinctly specific actions that the total effect is but in a minor degree referable to the potash. Such are the arsenite, bromide, iodide, and permanganate, and sulphurated potash. These will, therefore, be discussed under the head of their other constituents.

SODIUM. Na. 23.

The following are the officinal salts and preparations of sodium, arranged according to their source:

1. Sodæ Carbonas.—Carbonate of Soda. $Na_2CO_3, 10H_2O$.

Source.—Made from the ashes of marine plants, or from chloride of sodium by chemical decomposition.

Characters.—Transparent colourless laminar rhombic crystals, efflorescent, with a harsh alkaline taste, and alkaline reaction. 20 gr. neutralise 9·7 gr. of citric acid, or 10½ gr. of tartaric acid.

Impurities.—Sulphates and chlorides.

Dose.—5 to 30 gr.

From Sodæ Carbonas are made:

a. **Sodæ Carbonas Exsiccata.**—Dried Carbonate of Soda. Na_2CO_3. A dry white powder, made from Carbonate of Soda by drying. 53 gr. = 143 gr. of the crystallised salt. *Dose,* 3 to 10 gr.

b. **Sodæ Bicarbonas.**—Bicarbonate of Soda. $NaHCO_3$.

Source.—Prepared from a mixture of the Carbonate and Dried Carbonate by passing a stream of carbonic acid gas through them; $Na_2CO_3 + H_2O + CO_2 = 2(NaHCO_3)$.

Characters.—A white powder, or small opaque irregular scales, of a not unpleasant saline taste. 20 gr. neutralise 16·7 gr. of citric acid, or 17·8 gr. of tartaric acid. 1 part soluble in 10 of water.

Impurities.—Carbonate and its impurities.
Dose.—10 to 60 gr.

Preparations.

α. Liquor Sodæ Effervescens. — Soda Water. Made like potash water. 30 gr. in 1 pint. *Dose,* Ad libitum.

β. Trochischi Sodæ Bicarbonatis. — 5 gr. in each. *Dose,* 1 to 6.

γ. Sodæ Citro-Tartras Effervescens. — Effervescent Citro-tartrate of Soda. White granules, deliquescent; made by heating the Bicarbonate with Citric and Tartaric acids, stirring assiduously. *Dose,* 60 to 120 gr.

c. **Liquor Sodæ.**—Solution of Soda. $NaHO$ (4·1 per cent.) in water.

Source.—Prepared by boiling a solution of Carbonate of Soda with Slaked Lime. $Na_2CO_3 + CaH_2O_2 = 2NaHO + CaCO_3$.

Characters.—A colourless alkaline liquid.

Impurities.—Lime, carbonates, sulphates, chlorides.

Dose.—(Rarely given) 10 min. to 1 fl.dr.

From Liquor Sodæ are made:

α. **Soda Caustica.**—Caustic Soda. $NaHO$.

Source.—Made by boiling down Liquor Sodæ.

Characters. —Hard greyish-white fragments, slightly deliquescent, very alkaline.

Impurities.—Same as of liquor.

β. Sodæ Valerianas. See *Valerianæ Radix.*

d. **Sodæ Acetas.**—Acetate of Soda. $NaC_2H_3O_2.3H_2O$.

Source.—Made by acting on Carbonate of Soda by Acetic Acid.

Characters.—Transparent colourless crystals. Used only to make ferri arsenias, ferri phosphas, and syrupus ferri phosphatis.

e. **Soda Tartarata.** — Tartarated Soda. $NaK.C_4H_4O_6.4H_2O$. Tartrate of soda and potash. Rochelle salt.

Source.—Prepared by boiling Acid Tartrate of Potash in a solution of Carbonate of Soda, and crystallising; $Na_2CO_3 + 2KHC_4H_4O_6 = 2NaK.C_4H_4O_6 + H_2O + CO_2$.

Characters. — Colourless transparent right rhombic prisms, tasting like common salt. Solubility, 1 in 2 of water.

Impurities.—Acid tartrate of potash.

Dose.—$\frac{1}{4}$ to $\frac{1}{2}$ oz.

f. **Sodæ Sulphas.**—Sulphate of Soda. Glauber's salt. $Na_2SO_4.10H_2O$.

Source.—Prepared by adding Carbonate of Soda to the acid sulphate left in the manufacture of hydrochloric acid. $Na_2CO_3 + 2NaHSO_4 = 2Na_2SO_4 + CO_2 + H_2O$.

Characters.—Colourless transparent oblique rhombic prisms, efflorescent, with a bitter salt taste. 1 part soluble in 3 of water.

Impurities.—Salts of ammonium and iron.

Dose.—$\frac{1}{4}$ to 1 oz.

g. **Sodæ Phosphas.**—Phosphate of Soda. $Na_2HPO_4.12H_2O$.

Source.—Prepared by adding a solution of Carbonate of Soda to the acid product of the action of sulphuric acid on bone-ash, and crystallising. (1) $Ca_32PO_4 + 2H_2SO_4 = CaH_42PO_4 + 2CaSO_4$. (2) $CaH_42PO_4 + Na_2CO_3 = Na_2HPO_4 + CaHPO_4 + H_2O + CO_2$.

Characters.—Colourless transparent rhombic prisms, efflorescent, tasting like common salt. 1 part soluble in 5 of water. Used to make ferri phosphas and syrupus ferri phosphatis.

Impurity.—Phosphate of lime.

Dose.—$\frac{1}{4}$ to 1 oz.

h. **Sodæ Hypophosphis.**—Hypophosphite of Soda. $NaPH_2O_2$.

Source.—Prepared by adding Carbonate of Soda to a solution of Hypophosphite of Lime, and evaporating the solution. $Ca2PH_2O_2 + Na_2CO_3 = 2NaPH_2O_2 + CaCO_3$.

Characters.—A white granular deliquescent salt, with a bitter nauseous taste. 1 part soluble in 2 of water.

Dose.—5 to 10 gr.

i. **Sodæ Arsenias.**—Arseniate of Soda. $Na_2HAsO_4.7H_2O$.

Source.—Prepared by fusing Carbonate of Soda and Nitrate of Soda with Arsenious Acid, dissolving out and crystallising.

Characters.—Colourless transparent prisms. 1 part soluble in 2 of water.

Dose.—$\frac{1}{16}$ to $\frac{1}{8}$ gr.

Preparation.

Liquor Sodæ Arseniatis.—4 gr. dried to 1 oz. water. *Dose*, 5 to 10 min.

j. **Sodæ Chloratæ Liquor.**—Solution of Chlorinated Soda.

Source.—Made by passing a stream of Chlorine gas through a solution of Carbonate of Soda.

Characters.—A colourless liquid, with an odour of chlorine and an astringent taste; alkaline. A mixed solution of hypochlorite of soda, chloride of sodium, and carbonate of soda.

Dose.—10 to 20 min.

Preparation.

Cataplasma Sodæ Chloratæ.

2. Sodii Chloridum.—Chloride of Sodium. Common salt. $NaCl$.

Source.—Native.

Characters.—Small white crystalline grains, or transparent cubic crystals, free from moisture, with purely saline taste. 1 part soluble in $2\frac{3}{4}$ parts of water.

Dose.—10 to 240 gr.

Sodii Chloridum is used in making:

Acidum Hydrochloricum, Hydrargyri Perchloridum, and Hydrargyri Subchloridum.

3. Sodæ Nitras.—Nitrate of Soda. $NaNO_3$.

Source.—Native; purified by crystallisation from water.

Characters.—Colourless obtuse rhombohedral crystals, with a cooling saline taste.

Impurities.—Sulphates and chlorides.

Sodæ Nitras is used in making:

Sodæ Arsenias.

4. Sodæ Biboras.—Biborate of Soda. Borax. $Na_2B_4O_7.10H_2O$.

Source.—Native.

Characters.—Transparent colourless crystals, slightly efflorescent, weakly alkaline. 1 part soluble in 22 parts of cold water, or in 1 part of glycerine.

Dose.—5 to 40 gr.

Preparations.

a. Glycerinium Boracis.—1 to 4.
b Mel Boracis.—1 in 8.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, soda possesses an action similar to that of potash, but is much less frequently used as a **caustic**. Solutions of the carbonates may be employed to neutralise caustic acids; in eczema and itching disorders of the skin; and in extensive burns. Soda compounds with olive oil constitute hard soap.

Internally.—Soda closely resembles potash in its action on the alimentary canal, but is more powerful because much less diffusible, *i.e.* more slowly absorbed. It is **antacid** to the contents of the stomach, relieving acidity due to indigestion, in the form either of the bicarbonates, soda-water, the officinal lozenges, or as a mixture with sal-volatile and an essential oil, such as peppermint, given after meals. As a **stomachic**, stimulating the flow of the gastric juice, bicarbonate of soda is more commonly given than the other alkalies, in doses of gr. 8 to gr. 15, shortly before meals. Part of the salt at the same time becomes converted into the chloride, which assists the digestion of albumen. The alkali also liquefies tenacious mucus, and thus prevents decomposition, the juice reaching the food more freely. Common salt is a safe and available emetic.

The salts of soda, being much less diffusible than those of potash, pass on into the small intestine. Here the sulphate and phosphate of soda and tartarated soda (Rochelle salt) act as **saline purgatives**. The sulphate, which is a constituent of several natural purgative waters, including Carlsbad, Friedrichshall, Hunyàdi János, and Bilin, is the most powerful of these, producing an abundant watery evacuation. It is used as a hydragogue in dropsies, especially in ascites from liver disease, in congestion of the portal system, and as a habitual purgative. The phosphate is a milder, but sufficiently active, purgative, less unpleasant to the palate; it is often given to children. Soda tartarata, the purgative basis of the Seidlitz powder, is familiar as a milder intestinal stimulant, of use in completing the effect of purgative pills. The chloride is an anthelmintic.

2. ACTION ON THE BLOOD AND ITS USES.

The salts of soda are slowly absorbed into the blood, and slowly excreted from it, remaining in it chiefly as the bicarbonate and phosphate. Taken, as they constantly are, in food, these salts are the chief sources of the natural alkalinity of the liquor sanguinis, which may be increased by their medicinal exhibition as well as by the tartrate, Rochelle salt, and even the sulphate. This effect of soda as an **alkaliniser of the**

blood is taken advantage of in the cases referred to under potash, namely, gout and rheumatism, only less frequently; for although soda is less depressing, as we shall see, than potash, and more easily borne on the stomach, the slowness of its entrance into the blood, and its tendency to pass off by the bowels when the dose is increased, more than counteract these advantages. When a prolonged and moderate alkaline influence is desired, especially in dyspepsia with a tendency to constipation, soda is manifestly to be preferred.

3. SPECIFIC ACTION.

In medicinal doses, the salts of soda have **no specific influence** on any organ. This circumstance, which at first sight appears incredible, is due to the fact that the whole organism is saturated with soda, which participates in many of the ordinary tissue changes; that soda is admitted in large quantities by the food (especially vegetables and fruits); and that the moderate amount contained in medicinal doses does not appreciably affect metabolism. In this respect soda differs remarkably from potash, and is therefore said to produce none of the depressing effects of that drug. As we have just seen, advantage is taken of this negative action of soda in its therapeutical applications.

4. REMOTE LOCAL ACTION AND USES.

Soda is excreted by all the mucous surfaces, by the kidneys, by the liver, and possibly by the skin; and in passing through the various epithelial structures, it increases their activity, whilst it modifies the amount, composition, and reaction of their secretions. The action of the different salts naturally varies to a considerable extent, some affecting one organ more, some another. The sulphate and the phosphate of soda are, as we have seen, hydragogue purgatives by virtue of their *immediate* local action; but they are also stimulants of the intestinal glands, and are constantly being absorbed and excreted, re-absorbed and re-excreted, in their course along the bowel. (*See* Part III.) Both are also true **hepatic stimulants** or **direct cholagogues**; the phosphate more so than the sulphate. The value of these salts in hepatic and intestinal disorders, which has been already referred to, is therefore partly referable to their effect in increasing the bile. Soda tartarata has a similar but feebler action.

On the *kidneys* soda acts less powerfully as a **diuretic** than potash, increasing the water and the solid constituents, and diminishing or neutralising the acidity of the urine. The bicarbonate is the most useful salt of soda for this purpose; the acetate and nitrate, whilst also diuretic, are so inferior to the acetate and nitrate of potash, that they are very seldom employed. The tartarated soda may be usefully combined with other **alkalinisers of the urine**, as in the ordinary Seidlitz powder; and the effervescing citro-tartrate of soda is a convenient modification of much the same drugs. The use of these alkalinisers of the urine has been explained already.

The secretions of the *bronchi* are increased by soda; that is, the sputa become more abundant and more liquid, and are more easily expelled by cough. The bicarbonate and the chloride are specially **expectorant**, and are indicated in the early stages of bronchitis, and in recurrent slight bronchial catarrh, when secretion is deficient and cough harassing. The effects of soda on the stomach, blood, and urine add much to its usefulness in such cases. The stimulant effect of soda salts on ciliary action may also account in part for its expectorant action.

When a comprehensive view is taken of the action and uses of the salts of soda—locally in the alimentary canal, in the blood, in the tissues, and in the organs and passages where it is excreted from the body, it is found to be peculiarly indicated in a condition of system which may be called the "gouty," the "rheumatic," "acidity," or "chronic derangement of the liver," and which is specially characterised, amongst other symptoms, by catarrhs, or discharges from the mucous membranes, interfering with the functions of the part; by imperfect biliary activity and constipation; and by scanty, high-coloured, very acid urine. In such a condition great benefit may be derived from a course of alkaline waters. If the stomach be the principal seat of catarrh, *i.e.* if chronic indigestion be urgent, the more purely carbonated alkaline waters should be selected, such as those of Vichy, Bilin, and Ems. If the derangement chiefly involve the liver and intestines, the sulphated and salt ($NaCl$) waters will be more suitable, such as Carlsbad, Kissingen, Wiesbaden, and Marienbad. For chronic catarrh of the bladder and urinary passages, Ems, Vichy, Wildungen, and Carlsbad are indicated.

5. ACTION AND USES OF THE DIFFERENT SODA SALTS.

The action and uses of the preparations of soda may be summarised as follows, and the special action of some of the salts particularly noticed: *Soda Caustica* and *Liquor Sodæ* are for external use, but very rarely employed. *Sodæ Carbonas* and *Bicarbonas* (the former rarely, the latter almost invariably used) possess the action and uses of soda in general upon all parts. *Sodæ Citro-tartras* is like the carbonates, but milder. *Soda*

Tartarata is like the carbonates, but purgative; and more rapidly and distinctly diuretic and alkalinising, by virtue of the potash it contains. *Sodæ Acetas* and *Sodæ Nitras* are used pharmaceutically only. *Sodæ Sulphas* and *Sodæ Phosphas* are chiefly hydragogue purgatives and cholagogues, the former acting more on the bowels, the latter more on the liver. *Sodii Chloridum* is in large doses a free and safe emetic; an anthelmintic as enema; it possesses otherwise the ordinary action of soda, and is greatly used for this purpose as the waters of Homburg, Wiesbaden, Kissingen, and Baden-Baden, and as sea-water. The remaining salts of soda possess peculiar properties by virtue of their second constituent, and are described elsewhere—*Sodæ Arsenias* under Arsenic; *Sodæ Chloratæ Liquor*, under Chlorine; *Sodæ Hypophosphis* under Phosphorus; *Sodæ Biboras* under Acidum Boricum; *Sodæ Valerianas* under Valerianæ Radix.

AMMONIUM. NH_4. 18.

The following are the officinal salts and preparations of ammonium, arranged according to their source:

1. Ammonii Chloridum.—Chloride of Ammonium. Muriate of Ammonia. Sal Ammoniac. NH_4Cl.

Source.—Made by neutralising Ammoniacal Gas Liquor with Hydrochloric Acid, and evaporating. $NH_4HO + HCl = NH_4Cl + H_2O$.

Characters.—Colourless translucent fibrous masses, inodorous and tough. Solubility, 1 in 4 of water; soluble in spirit.

Impurities.—Iron and lead.

Dose.—5 to 20 gr.

From Ammonii Chloridum are made:

a. **Liquor Ammoniæ Fortior.**—Strong solution of Ammonia. NH_3 (32·5 per cent.) in water.

Source.—Made by heating Chloride of Ammonium with Slaked Lime, and collecting the gaseous product in water. $2NH_4Cl + CaH_2O_2 = 2NH_3 + CaCl_2 + 2H_2O$.

Characters.—A colourless liquid with a very pungent characteristic odour, and strong alkaline reaction.

Impurities.—Ammonium chloride, sulphide, and sulphate; lime, and metals. Detected by usual tests.

Preparations.

a. Linimentum Camphoræ Compositum.—Compound Liniment of Camphor. Strong solution of Ammonia, Camphor, Rectified Spirit, and Oil of Lavender; 1 in $4\frac{1}{2}$.

β. **Liquor Ammoniæ Citratis.**—Solution of Citrate of Ammonia. $3NH_4.C_6H_5O_7$ dissolved in water. Made by adding Strong Solution of Ammonia to a solution of Citric Acid.

Dose.—2 to 6 fl.dr.

γ. **Spiritus Ammoniæ Aromaticus.**—Aromatic Spirit of Ammonia. Sal-volatile. Made by distilling a mixture of Strong Solution of Ammonia, Carbonate of Ammonia, Volatile Oil of Nutmeg, Oil of Lemon, Spirit, and Water.

Dose.—½ to 1 fl.dr.

> *Spiritus Ammoniæ Aromaticus is used in preparing* Tinctura Guaiaci Ammoniata, and Tinctura Valerianæ Ammoniata.

δ. **Spiritus Ammoniæ Fœtidus.**—Fetid Spirit of Ammonia. Made by adding Strong Solution of Ammonia to an extract made from Assafœtida macerated in spirit.

Dose.—½ to 1 fl.dr.

ε. Tinctura Opii Ammoniata. See *Opium.*

From Liquor Ammoniæ Fortior are made :

ζ. **Ammoniæ Phosphas.**—Phosphate of Ammonia. $(NH_4)_2HPO_4$.

Source.—Made by adding Strong Solution of Ammonia to Diluted Phosphoric Acid, evaporating and crystallising.

Characters.—Transparent colourless prisms, becoming opaque by exposure. Solubility, 1 in 2 of water.

Dose.—5 to 20 gr.

η. **Liquor Ammoniæ.**—Solution of Ammonia. NH_3 (10 per cent.) dissolved in water.

Source.—Made by mixing one part of Strong Solution of Ammonia with two parts of Distilled Water.

Dose.—10 to 20 min. diluted.

Preparation.

Linimentum Ammoniæ.—Liniment of Ammonia. Solution of Ammonia, 1 ; Olive Oil, 3.

From Liquor Ammoniæ are made :

i. **Ammoniæ Benzoas.**—Benzoate of Ammonia. $NH_4.C_7H_5O_2$.

Source.—Made by dissolving Benzoic Acid in Solution of Ammonia, evaporating, and crystallising.

Characters.—Colourless laminar crystals, with a characteristic odour. Solubility, 1 in 5 of water.

Dose.—10 to 20 gr.

ii. **Ammoniæ Nitras.**—Nitrate of Ammonia. NH_4NO_3.

Source.—Made by neutralising Diluted Nitric Acid with Solution of Ammonia (or Carbonate of Ammonia), crystallising, and fusing.

Characters.—A white deliquescent salt, in confused crystalline masses, with a bitter acrid taste.

Used only for making nitrous oxide gas (N_2O).

b. **Ammoniæ Carbonas.**—Carbonate of Ammonia. $N_4H_{16}C_3O_8$.

Source.—Made by subliming a mixture of Chloride of Ammonium (or Sulphate of Ammonia), with Carbonate of Lime. $6NH_4Cl + 3CaCO_3 = N_4H_{16}C_3O_8 + 3CaCl_2 + 2NH_3 + H_2O$.

Characters.—Translucent crystalline masses, volatile and pungent to the nose; alkaline. Solubility, 1 in 4 of water. 20 gr. neutralise 23½ gr. citric acid, or 25½ gr. tartaric acid; 15 gr. neutralise 17 gr. citric acid, or one tablespoonful of lemon juice.

Impurities.—Sulphates and chlorides.

Dose.—3 to 10 gr.

From Ammoniæ Carbonas are made:

α. Spiritus Ammoniæ Aromaticus. *See* page 43.

β. **Liquor Ammoniæ Acetatis.**—Solution of Acetate of Ammonia. $NH_4.C_2H_3O_2$ dissolved in water.

Source.—Made by neutralising Carbonate of Ammonia by Acetic Acid, and adding water.

Dose.—2 to 6 fl.dr.

Ammonii Chloridum is used in making Liquor Hydrargyri Perchloridi.

2. Ammonii Bromidum.—Bromide of Ammonium. NH_4Br.

Characters.—Colourless crystals, which become slightly yellow by exposure to the air, and have a pungent saline taste. Solubility, 1 in $1\frac{1}{2}$ of water.

Impurities.—Iodides; free bromine. Detected by colour.

Dose.—2 to 20 gr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally applied, ammonia is a **stimulant** to the nerves and other structures, causing a sensation of pain and burning, and reddening the part by dilating the vessels. If the application be prolonged and the vapour confined, blistering may result; but dilute preparations produce only a rubefacient effect and a sense of heat. It is used in the form of liniment to stimulate the circulation in a part, either for the purpose of increasing the local nutrition (for instance, in stiffness or other chronic conditions of joints), or as a **counter-irritant** (*see* Part III.) in diseases of deeper parts, *e.g.* on the surface of the chest in bronchitis. Ammonia is not to be used as a caustic; and vesication by it is better avoided. In serpent's bite, the application of ammonia to the wound has occasionally saved life.

Internally.—Admitted into the *nose*, ammonia itself, or the vapour of the carbonate ("smelling salts"), is a powerful **general stimulant**, instantly causing a pungent sensation, sneezing and other disturbances of the respiration, acceleration of the pulse, and watery secretion from the parts including the conjunctiva. It is accordingly used as a means of resuscitating consciousness, the action of the heart, and respiration, in cases of failure of the circulation, such as fainting, or of asphyxia.

In the *stomach*, ammonia produces the same effects as on the skin. A full dose (30 gr. of the carbonate well diluted) is an **emetic**, which is best used in croup and bronchitis. Smaller doses cause a sense of warmth at the epigastrium, and act as **carminatives**, sal-volatile being chiefly used for this purpose. In common with soda and potash, it has an **antacid** effect on the contents of the stomach, and may be given after meals in dyspepsia. Like these, also, it acts as a natural stimulant to the gastric juice before meals, and sal-volatile is therefore a common ingredient of alkaline stomachic mixtures. On the bowels, ammonia appears to have no *local* action.

2. ACTION ON THE BLOOD, AND ITS USES.

Ammonia is absorbed into the blood, and is there fixed; increasing, possibly, the alkalinity of the plasma, and diminishing the tendency to coagulation. The phosphate is believed to be useful in gout, by keeping uric acid in solution.

3. SPECIFIC ACTION AND USES.

Although its specific action is still imperfectly known, ammonia certainly appears to stimulate the central nervous system generally, the respiratory centre, and the heart; that is, to be a **general stimulant.** It is much given in neuralgia (as the chloride), and in exhausted states of the vital powers, especially if respiration and circulation threaten to fail, as in typhoid fever complicated with pneumonia, in the bronchitis of old or weakly subjects, and in ordinary acute pneumonia with increasing feebleness of the heart. In this way also it is useful in serpent's bite, and is given internally in water, or hypodermically (10 to 20 minims) whilst it is applied to the wound. The phosphate directly increases the amount of bile, etc.; chloride of ammonium decidedly increases the production of urea, partly, at least, by its own decomposition in the liver.

4. REMOTE LOCAL ACTION, AND USES.

Ammonia is excreted by the kidneys and mucous membranes, especially the respiratory tract; not, however, as ammonia, but as some other nitrogen compound. Thus, instead of diminishing, it actually **increases the acidity of the urine,** whilst the amount of urea and uric acid also rises, as well as the volume of the secretion. The chloride of ammonium possesses these important powers most fully, the acetate less fully. They are employed as **diuretics** in dropsies and feverish states of the system.

The *bronchial* secretion is distinctly increased, and rendered more liquid and easily raised, by the carbonate and chloride of ammonium. These salts prove of great service as **expectorants** in the treatment of bronchitis when the secretion is scanty and thick, or the patient feeble; the accompanying stimulation of the respiratory centre increasing the coughing or expectorant power, whilst the heart is also sustained.

The mucous secretion of the *stomach* is affected by ammonia as by the other alkalies, and the chloride is sometimes used in chronic dyspepsia. Ammonia remotely stimulates the intestines, and will cause diarrhœa if given in large doses.

On the *skin* the acetate of ammonia acts as a well-marked remote stimulant, and as the Liquor is one of our most common **diaphoretics**. The chloride also possesses the same property, but to a less degree.

5. ACTION AND USES OF THE DIFFERENT SALTS OF AMMONIA.

These may be thus summarised: *Liquor Ammoniæ Fortior* and *Liquor Ammoniæ* are used as stimulants and vesicants, the former externally only. *Ammoniæ Carbonas*—a volatile stimulant, emetic, and double expectorant (through the nerves and secretions). *Ammonii Chloridum*—a local refrigerant, a gastric, intestinal, and hepatic stimulant, nervous stimulant, diuretic double expectorant, and diaphoretic (hence called an "alterative"). *Liquor Ammoniæ Acetatis*—diaphoretic and diuretic (febrifuge), and nervous stimulant. *Liquor Ammoniæ Citratis* — diuretic and diaphoretic. *Spiritus Ammoniæ Aromaticus* — agreeable and powerful carminative, antacid, and general stimulant. *Ammoniæ Phosphas*—direct cholagogue, possibly an alkaliniser of the blood. *Spiritus Ammoniæ Fœtidus.* (See *Assafœtida.*) *Ammoniæ Benzoas.* (See *Benzoin.*) *Ammonii Bromidum.* (See *Bromum.*)

LITHIUM. L. 7.

Only two salts of this metal are officinal:

Lithiæ Carbonas.—Carbonate of Lithia. L_2CO_3.

Characters.—A white powder, or minute crystalline grains; alkaline. Solubility, 1 in 100 of water.

Impurities.—Lime, alumina; detected by lime-water. Deficiency of lithia; detected by weight of residue.

Dose.—3 to 6 gr., in 3 or 4 oz. of aërated water.

Preparation.

a. Liquor Lithiæ Effervescens.—Effervescing Solution of Lithia. Lithia Water. Made like Potash Water. 10 gr. to 1 pint. *Dose,* 5 to 10 fl.oz.

From Lithiæ Carbonas is made:

b. **Lithiæ Citras.**—Citrate of Lithia. $L_3C_6H_5O_7$.

Source.—Made by dissolving Carbonate of Lithia in a solution of Citric Acid, and evaporating.

Characters.—A white amorphous deliquescent powder. Solubility, 1 in 2½ of water. *Dose,* 5 to 10 gr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION.

Externally, lithia may be used as a fomentation in gout.

Internally, lithium has doubtless an **antacid** action on the alimentary canal very similar to that of potash, but it is not used for this purpose directly.

2. ACTION ON THE BLOOD, AND ITS USES.

Lithium enters the blood, and behaves there much like potash, **increasing its alkalinity**, and combining with such acid bodies as uric acid, for which it has a powerful affinity, (1 part of a solution of the carbonate of lithia, at 38° C., dissolving four parts of the acid). It is extensively used in gout, to hold this substance in solution, and thus prevent acute attacks by fresh deposit in the tissues.

3. SPECIFIC ACTION AND USES.

In this respect also lithia closely resembles potash, being a cardiac and nervo-muscular **depressant**, if given in large doses or for a length of time; but the risk of lithia poisoning is too small to be allowed to interfere with the exhibition of the drug in suitable cases.

4. REMOTE LOCAL ACTION AND USES.

Lithium is rapidly excreted by the kidneys, and probably by the mucous membranes. It is a powerful **diuretic** in passing through the renal epithelium; and whilst increasing the volume of water, it **diminishes its acidity**, and holds in solution even an excess of uric acid. It is accordingly used as a valuable remedy in gout, as it hastens the excretion of the products which it dissolves in the blood; and in acid lithiasis or gravel, where it prevents the deposit of salts in the kidney and urinary passages.

Both of the salts of lithia may be used, the only important difference between them being with respect to their solubility, which is very marked.

CALCIUM. Ca. 40. LIME.

Creta or chalk is naturally discussed along with calcium or lime, of which it is the carbonate.

The various preparations of lime may be represented as follows, according to their source.

1. Creta.—Chalk. $CaCO_3$ (impure). Native.

From Creta are made:

a. **Creta Præparata.**—Prepared Chalk. $CaCO_3$ (nearly pure).

Source.—Made from Chalk by elutriation and subsequent drying.

Characters.—A white amorphous powder, insoluble in water; incompatible with all acids and sulphates.

Impurities.—Alumina and oxide of iron.

Dose.—10 to 60 gr.

Preparations.

a. Mistura Cretæ.—Chalk Mixture. Prepared Chalk, Gum Acacia, Syrup, and Cinnamon Water. 1 in 32. *Dose*, 1 to 2 fl.oz.

β. Pulvis Cretæ Aromaticus.—Aromatic Powder of Chalk. Prepared Chalk, Cinnamon, Nutmeg, Saffron, Cloves, Cardamoms, and Sugar. 1 in 4. *Dose*, 10 to 60 gr.

From Pulvis Cretæ Aromaticus is made:

i. Pulvis Cretæ Aromaticus cum Opio.—Aromatic Powder of Chalk and Opium. 39 parts of Aromatic Chalk Powder, mixed thoroughly with 1 part of Opium in powder. 1 of opium in 40. *Dose*, 10 to 40 gr.

γ. Hydrargyrum cum Cretâ.—Mercury with Chalk. Mercury, 1; Prepared Chalk, 2. *Dose*, 3 to 8 gr.

b. **Calx.**—Lime. CaO (with some impurities).

Source.—Made by calcining Chalk. $CaCO_3 = CaO + CO_2$.

Characters.—Compact whitish masses.

From Calx is made:

a. **Calcis Hydras.**—Slaked Lime. Hydrate of Lime. CaH_2O_2 (with some impurities).

Source.—Made by slaking Lime with distilled water. $CaO + H_2O = CaH_2O_2$.

Characters.—A white powder, strongly alkaline. Soluble in 900 parts of water. Incompatible with vegetable and mineral acids, alkaline and metallic salts, and tartar emetic.

Preparations.

i. **Liquor Calcis.**—Solution of Lime. Lime Water. Made by shaking up Slaked Lime in Distilled Water, and decanting after the excess has subsided. ½ gr. of lime in 1 fl.oz. *Dose*, ½ to 4 oz.

From Liquor Calcis is prepared :

Linimentum Calcis. — Liniment of Lime. Solution of Lime and Olive Oil, equal parts mixed.

Liquor Calcis is also used in preparing Lotio Hydrargyri Flava, Lotio Hydrargyri Nigra, and Argenti Oxidum.

ii. **Liquor Calcis Saccharatus.**—Saccharated Solution of Lime. Made by digesting Slaked Lime with Sugar and Water, and straining. 7·11 grains of lime in 1 fl. ounce. *Dose*, 15 to 60 min.

From Calcis Hydras are made :

iii. **Calx Chlorata.**—Chlorinated Lime. "Chloride of Lime." $CaCl_2O_2, CaCl_2$.

Source.—Made by passing Chlorine gas over Slaked Lime. $2CaH_2O_2 + 2Cl_2 = CaCl_2O_2, CaCl_2 + 2H_2O$. Partially soluble in water, bleaches and disinfects.

Impurities. — Deficiency in chlorine; detected by volumetric test.

Characters.—A dull white powder, with a feeble odour of chlorine.

Preparations.

(1) Liquor Calcis Chloratæ.—Solution of Chlorinated Lime. 1 pound to 1 gallon of Water; mixed, agitated, and strained. See *Chlorum*.

(2) Vapor Chlori. Inhalation of Chlorine. Chlorinated Lime, moistened with cold water, to disengage chlorine. See *Chlorum*.

Calx chlorata is also employed in preparation of Chloroform. See *Chloroformum*.

iv. **Calcis Hypophosphis.**—Hypophosphite of Lime. $Ca2PH_2O_2$.

Source.—Made by heating Slaked Lime and Water with Phosphorus, purifying the liquid, and crystallising. $3CaH_2O_2 + P_8 + 6H_2O = 3(Ca2PH_2O_2) + 2PH_3$.

Characters. — White pearly crystals, with a nauseous taste. Soluble in 6 parts of cold water; insoluble in spirit.

Dose.—5 to 10 gr.

Calcis Hypophosphis is used to make:

(1) Sodæ Hypophosphis.—See *Soda.*

c. **Calcii Chloridum.**—Chloride of Calcium. $CaCl_2$.

Source.—Made by neutralising Hydrochloric Acid with Chalk, and evaporating to dryness. $CaCO_3 + 2HCl = CaCl_2 + CO_2 + H_2O$.

Characters.—White, very deliquescent masses; solubility, 1 in 2 of water.

Impurities.—Carbonates, salts of alumina, and iron; Hypochlorites, detected by evolving Cl with HCl.

Dose.—10 to 20 gr.

Calcii Chloridum is used to make:

a. **Calcis Carbonas Præcipitata.**—Precipitated carbonate of lime. $CaCO_3$.

Source.—Made by mixing boiling solutions of Chloride of Calcium and Carbonate of Soda, and washing the precipitate. $CaCl_2 + Na_2CO_3 = CaCO_3 + 2NaCl$.

Characters.—A white crystalline powder, insoluble in water. *Dose,* 10 to 60 gr.

Calcis Carbonas Precipitata is contained in Trochisci Bismuthi (4 gr. in each).

2. Calcis Phosphas.—Phosphate of lime. Ca_32PO_4.

Source.—Made by (1) dissolving Bone-ash in Hydrochloric acid; and (2) adding Solution of Ammonia, and washing and drying the precipitate. (1) $Ca_32PO_4 + 4HCl = CaH_42PO_4 + 2CaCl_2$; (2) $CaH_42PO_4 + 2CaCl_2 + 4NH_4HO = Ca_32PO_4 + 4NH_4Cl + 4H_2O$.

Characters.—A light white amorphous powder, insoluble in water.

Dose.—10 to 20 gr.

Calcis Phosphas is contained in:

Pulvis Antimonialis (2 parts in 3). See *Antimonium.*

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Lime in the form of the hydrate is **caustic,** like the alkalies, but its action is more localised, so that it may be combined with fused potash to form a convenient caustic, *potassa cum calce*, Vienna paste, for ordinary use. Dusted on the skin as chalk, or applied in lime-water, it is **astringent** and **desiccative** (drying), and is used to promote the healing of burns, eczema, and ulcers. The linimentum calcis is a valuable application to burns.

Internally.—The local effect of lime is **antacid**, like the alkalies and magnesia, combined with an astringency peculiar to itself. In the mouth, chalk is used as an antacid and physical dentifrice. Admitted into the stomach and intestines, as lime-water or the carbonate, lime unites with the free acids of the contents, and acts upon the structures of the gastric wall. It is accordingly useful in acid dyspepsia, with heartburn, given after food, *e.g.* as the bismuth lozenge. Lime-water prevents the gastric juice from curdling milk in large lumps, and is extensively given to artificially-reared infants, the liquor calcis saccharatus being an excellent form when dilution of the food is injurious. Its power of combination with acids also makes lime a valuable **antidote** for poisoning by the mineral acids, oxalic acid, and chloride of zinc, and one which is always available in the form of wall-plaster; it must be freely given. The action of lime on the glands of the stomach appears to be depressant, and it is, therefore, not suited for administration before meals. Lime-water is, indeed, a general **gastric sedative** of some value, arresting some kinds of vomiting, especially in the acid dyspepsia of infants, and in pregnancy.

But little of the alkaline effect of lime or chalk can remain in the bowels beyond what has been exerted on the chyme. The **astringent** action of these familiar drugs in diarrhœa may be in part due to their antacid property, in part to an obscure sedative effect on the intestinal glands (? and vessels), which diminishes the excretion of water into the bowel. The lime salts can be traced along the whole length of the canal, and most of their bulk is finally expelled unabsorbed. Lime and chalk thus come to be two of our most valuable astringents in diarrhœa, either alone or with aromatics, opium, or vegetable astringents, as in the officinal preparations.

Lime-water is also employed locally as an enema for killing the thread-worm, and as a vaginal injection in leucorrhœa.

2. ACTION ON THE BLOOD.

Lime enters the circulation in very small quantities only, and appears in the serum as the phosphate. It probably increases the alkalinity somewhat, but no special use is made of it for this purpose.

3. SPECIFIC ACTION AND USES.

The important part played by lime as a constituent of bones has suggested its use as a specific remedy in rickets, fractures, and other lesions of these structures; and the phosphates and lime-water are extensively used for the two former conditions. The phosphate and the chloride have been recommended in scrofulous diseases of glands and phthisis, to promote absorption, or possibly to induce calcification; and apparently with some reason. None of the calcareous mineral waters, however, are of much service in this respect.

4. REMOTE LOCAL ACTION AND USES.

The greater part of lime or its salts being expelled by the bowel, little remains to be excreted by the kidney, so that their diuretic and alkaline effects are not marked. Their most useful form for influencing the urine is Bath or Wildungen water.

5. ACTION AND USES OF THE DIFFERENT SALTS OF LIME.

Creta in its various forms and combinations—*Liquor Calcis* and *Liquor Calcis Saccharatus*—possesses the general effects and uses of lime. *Calcii Chloridum* is a gastric sedative, but is also a specific in scrofulous enlargement of glands; and is used in testing. *Calcis Phosphas* is a specific in bone diseases and scrofula. *Calx Chlorata* and its derivates are media for supplying chlorine, and used accordingly. *Calcis Hypophosphis* is employed as a specific in tuberculosis and other wasting diseases. In the remaining preparations the action of the lime or chalk is comparatively insignificant, as, *e.g.*, in the three preparations of mercury, of which they are ingredients, and in antimonial powder.

MAGNESIUM. Mg. 24.

The following are the officinal salts and preparations of magnesium, arranged according to their source:

Magnesiæ Sulphas.—Sulphate of Magnesia. Epsom Salt. $MgSO_4.7H_2O$.

Source.—Native.

Characters.—Minute colourless rhombic prisms, with a bitter taste. Solubility, 10 in 13 parts of cold water. Incompatible with alkaline carbonates, lime-water, acetate of lead, and nitrate of silver.

Impurities.—Lime, iron, and general impurities.
Dose.—60 gr. to ½ oz.

Preparations.

a. Enema Magnesiæ Sulphatis.—1 oz., in 1 oz. of Olive Oil, and 15 oz. of Mucilage of Starch; for one enema.

b. Mistura Sennæ Composita.—1 oz. in 5 fl.oz. See *Senna.*

From Magnesiæ Sulphas are also made:

c. **Magnesiæ Carbonas.**—Carbonate of Magnesia (heavy). $(MgCO_3)_3.MgO.5H_2O$.

Source.—Made by mixing boiling solutions of Sulphate of Magnesia and Carbonate of Soda, evaporating, purifying, and drying. $4MgSO_4 + 4Na_2CO_3 + H_2O = 3MgCO_3,Mg2HO + 4Na_2SO_4 + CO_2$.

Characters.—A white granular powder, insoluble in water.

Impurities.—Lime, sulphates, metals.

Dose.—10 to 60 gr.

Preparations.

α. **Liquor Magnesiæ Carbonatis.**—Solution of Carbonate of Magnesia. "Fluid Magnesia." $MgCO_3 + H_2CO_3$ or MgH_22CO_3, in solution.

Source.—Made by passing an excess of Carbonic Acid gas through a mixture of Carbonate of Magnesia (freshly prepared) and water. 1 fl.oz. contains 13 gr. of carbonate.

Characters.—A clear fluid, sometimes effervescing slightly.

Dose.—1 to 2 fl.oz.

β. Trochisci Bismuthi.—2½ gr. in each.

From Magnesiæ Carbonas is made:

Magnesia.—Magnesia (heavy). Magnesia Ponderosa. MgO.

Source.—Made by heating Carbonate of Magnesia in a crucible to expel the carbonic acid.

Characters.—A white powder, comparatively insoluble in water (1 part in 5,412 cold water, 1 in 36,000 hot water).

Impurities.—Those of the carbonates.

Dose.—10 to 60 gr.

d. **Magnesiæ Carbonas Levis.**—Light Carbonate of Magnesia. $(MgCO_3)_3.MgO.5H_2O$.

Source.—Made like magnesiæ carbonas, but with cold dilute solutions instead of hot.

Characters.—A very light white powder, proving microscopically to be partly amorphous, partly prismatic crystals. Soluble in 2,493 parts of cold water, or in 9,000 parts of hot water; 3½ times the bulk of the heavy carbonate.

Dose.—10 to 60 gr.

From Magnesiæ Carbonas Levis is made:

Magnesiæ Levis.—Light Magnesia. MgO.

Source.—Made by heating Light Carbonate of Magnesia in a crucible to expel the carbonic acid.

Characters.—A bulky white powder, 3½ times the bulk of heavy magnesia.

Dose.—10 to 60 gr.

Magnesiæ Carbonis Levis is contained in Pulvis Rhei Compositus (6 parts in 9).

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, magnesia has no action, and is not used.

Internally, magnesia is a valuable means of decomposing the contents of the stomach and intestines under various circumstances. The base and carbonates form comparatively insoluble or innocuous compounds with the mineral acids, oxalic acid, mercuric, arsenical, and cupric salts; in large quantities they prevent the absorption of alkaloids by rendering the contents of the stomach alkaline; whilst the sulphate precipitates insoluble sulphates of lead and baryta. Magnesia or its salts may therefore be employed as **antidotes** in cases of poisoning by any of these substances, the oxide being preferred to the carbonate, so as to prevent the evolution of carbonic acid, and care being taken to give it very freely.

By a similar process of decomposition, magnesia **neutralises** normal or excessive **acidity** in the stomach and bowels, and is itself converted into the chloride, lactate, and bicarbonate, this reaction removing irritant acid, and forming salts of magnesia, which have a stimulant or purgative action on the intestine. The carbonate is similarly decomposed, yielding carbonic acid, which exerts its specific action on the stomach. Both substances are therefore employed as local **alkaline remedies** in acidity of the stomach (heartburn, pyrosis, etc.), given with sal-volatile, after meals, a further laxative effect on the intestine being intended.

The chloride, bicarbonate, or lactate formed in the stomach, and the sulphate of magnesia directly given, having reached the intestine, are very slowly absorbed, and if in sufficient quantity, produce very marked local effects as **saline purgatives**, the sulphate being hydragogue in its action. The result is the free evacuation of a quantity of water by the bowel, and with it the whole, or almost the whole, of the magnesia. Sulphate of magnesia (Epsom salt) is our most common saline purgative, used in the form of Mistura Sennæ Composita (black draught), of a simple solution in sulphuric acid and water with some carminative, and of several of the popular aperient waters, such as Friedrichshall, Püllna, Hunyàdi Jànos, of all of which it is an important constituent. Sulphate of magnesia is regarded as a mild, painless, non-nauseating purgative, less rapid in its action than the soda salt, to be used for completing the effect of purgative pills, for congestion of the portal system, for chronic constipation as an habitual laxative in combination with other salts in the above-named waters, and for feverish attacks with loaded bowels.

Magnesia and the carbonates, when used as purgatives, are chiefly given to children in diarrhœa with foul acid stools, very frequently in the form of Pulvis Rhei Composita (Gregory's Powder). In small doses, neither salt has any purgative action on the bowel, but enters the blood.

2. ACTION ON THE BLOOD AND ITS USES.

Entering the circulation as the chloride or lactate, magnesia **increases** the natural **alkalinity** of the plasma, of which it is a normal constituent, and helps to hold in solution any acid which may be in excess. It will therefore be useful in gout, lithiasis, and possibly in chronic rheumatism, to assist the more powerful alkalinisers of the blood with which it is combined in the waters of Ems, Baden-Baden, Aix-les-Bains, Carlsbad, etc.

3. SPECIFIC ACTION AND USES.

Magnesia taken medicinally does not exert any appreciable effect upon the tissues or nutrition generally. Although an important constituent of bone, it cannot be said to be of any value in rickets or other diseases in which the osseous tissue is deficient in solid matter.

4. REMOTE LOCAL ACTION.

When magnesia does not purge, it is excreted chiefly by the kidneys, rendering the urine more abundant and less acid, and dissolving uric acid. Its **diuretic** and **alkalinising** effects contribute to the value of magnesia waters in gout and gravel.

BARIUM. Ba. 137.

Barium is chiefly used in testing.

Chloride of Barium, $BaCl_2.2H_2O$.
Characters.—Colourless translucent tables.
Dose.—½ to 2 gr.

Solution of Chloride of Barium, 1 in 10.

ACTION AND USES.

Baryta greatly **disturbs the blood pressure,** and the chloride has accordingly been recommended in aneurism.

GROUP II.

THE METALS.

ALUMINIUM. Al. 27·5.

Only one salt of this metal is used in medicine.

Alumen.—Alum. $NH_4Al(SO_4)_2.12H_2O$. A sulphate of ammonia and alumina, crystallised from solution in water.

Characters.—Colourless transparent octahedra, with an acid, sweetish, astringent taste. Solubility, 1 in 12 of cold, and in ⅓th parts of boiling water. *Incompatible* with alkalies, lime, barytas, lead, tartrates, and tannic acid, mercury, and iron.

Impurity.—Sulphate of Iron.

Dose.—10 to 20 gr.

From Alumen is made :

Alumen Exsiccatum.—Dried Alum.

Source.—Made by heating alum up to 400° till aqueous vapours cease to be disengaged, and powdering.

Characters.—An opaque white bulky powder, or spongy masses. Has lost 47 per cent. by heating; difficult of solution in water, but unites readily with it.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Alum is **astringent**, an effect which is fully discussed under *Plumbum.* The dried alum absorbs water, and is somewhat **caustic** if the skin be broken, for instance, over ulcers. It is used to destroy weak exuberant granulations.

Internally.—The local action of alum is appreciated in the mouth as an "astringent taste," and in the throat as "dryness," the mucous secretions of the parts being coagulated, and the membrane constringed, especially if the parts be inflamed and swollen. Alum is therefore a remedy for sore throat, in the form of gargles or sprays, variously combined with other substances.

A similar effect is produced on the mucous membrane of the stomach and intestines, dyspepsia and constipation being the result; in large doses it is an **emetic**, irritant, and purgative. A teaspoonful mixed with syrup is an excellent vomit in croup. As an injection in discharges from the vagina, uterus, and urethra, it is in constant use; and also as a wash for the eyes.

2. ACTION IN THE BLOOD.

Alum is absorbed into the blood, probably as an albuminate.

3. SPECIFIC ACTION AND USES.

This salt is believed to possess astringent properties when it reaches the tissues, arresting hæmorrhage and chronic inflammatory discharges from the mucous membranes; and is used in the treatment of hæmoptysis, epistaxis, gleet, diarrhœa, and even whooping cough. Much of this is doubtful.

4. REMOTE LOCAL ACTION AND USES.

Alum is excreted by the kidneys, and may arrest hæmorrhage from these organs. Part of the salt may also escape by the skin, as it proves useful in some cases of excessive sweating.

PLUMBUM. Pb. 207. LEAD.

Lead is one of the most powerful and useful of metallic drugs.

1. Plumbi Oxidum.—Oxide of Lead. Litharge. PbO.

Characters.—Heavy scales of a pale brick-red colour. Soluble in diluted nitric and acetic acids.

Impurities.—Copper, iron, and carbonates; detected by ordinary tests.

Preparations.

Emplastrum Plumbi.—Lead Plaster. 1 in 2½ of Olive Oil and 1 of Water.

Plumbi Oxidum or its Emplastrum is also contained in Emplastra Ferri, Galbani, Hydrargyri, Resinæ, Cerati Saponis, and Saponis.

From Plumbi Oxidum is made:

Plumbi Acetas.—Acetate of Lead. "Sugar of Lead." $Pb(C_2H_3O_2)_2.3H_2O$.

Source.—Made by dissolving Oxide of Lead in Acetic Acid and Water, and crystallising. $PbO + 2C_2H_4O_2 = Pb(C_2H_3O_2)_2 + H_2O$.

Characters.—White spongy-looking masses of interlaced acicular crystals, slightly efflorescent, having an acetous odour and a sweet astringent taste. Solubility, 10 in 25 of water.

Incompatibles.—Hard water, mineral acids and salts, vegetable acids, alkalies, lime-water, iodide of potassium, all vegetable astringents, preparations of opium, albuminous liquids.

Impurity.—Carbonate; detected by turbidity of aqueous solution.

Dose.—1 to 4 gr.

Preparations.

a. Pilula Plumbi cum Opio.—Acetate of Lead, 6; Opium, 1; Confection of Roses, 1. A 4-gr. pill contains 3 gr. of plumbi acetas, and ½ gr. of opium.

Dose.—3 to 5 gr.

b. Suppositoria Plumbi Composita.—Each 15-gr. suppository contains 3 gr. of acetate of lead, and 1 gr. of opium.

c. Unguentum Plumbi Acetatis.—12 gr. to 1 oz. benzoated lard.

d. Liquor Plumbi Subacetatis.—"Goulard extract." $Pb_2C_4H_6O_5$, dissolved in water.

Source.—Made by boiling acetate of lead and oxide of lead in water.

Characters.—A dense, clear, colourless liquid, with a sweet astringent taste and alkaline reaction.

From Liquor Plumbi Subacetatis are prepared:

α. Liquor Plumbi Subacetatis Dilutus.—"Goulard Water." Solution of Subacetate of lead, 1; Rectified spirit, 1; Water, 78.

β. Unguentum Plumbi Subacetatis Compositum.—1 in 5¾.

2. Plumbi Carbonas.—Carbonate of Lead. "White Lead." $PbCO_3$.

Characters.—A heavy white powder. Insoluble in water.
Impurities.—Lime; sulphate of lead.

Preparation.

Unguentum Plumbi Carbonatis.—1 in 8.

3. Plumbi Nitras.—Nitrate of Lead. $Pb(NO_3)_2$.

Source.—Made by dissolving lead in boiling nitric acid slightly diluted, and crystallising out.

Characters.—Colourless octahedral nearly opaque crystals.

From Plumbi Nitras is made:

Plumbi Iodidum.—Iodide of Lead. PbI_2.

Source.—Made by mixing solutions of Nitrate of Lead and Iodide of Potassium. $Pb2(NO_3) + 2KI = PbI_2 + 2KNO_3$.

Characters.—A bright yellow powder or crystalline scales.

Preparations.

a. Emplastrum Plumbi Iodidi.—1 in 9.
b. Unguentum Plumbi Iodidi.—1 in 8.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Lead is said not to be absorbed by the unbroken skin; yet the dilute solution of the subacetate (Goulard water) is of unquestionable value in the treatment of contusions and superficial inflammations, such as erysipelas, and is extensively used in these conditions. In the same form, or as the ointment of the subacetate, it relieves itching; a symptom, the cause and pathological nature of which are still obscure. Lead may be absorbed when applied in the form of ointment, probably by decomposition; and the specific effects to be presently described may arise in this way. Lead salts act readily upon wounds, ulcers, and exposed mucous membranes: (1) precipitating the albuminous fluids which cover their surface, or are flowing from them as a discharge; (2) coagulating the protoplasm of the young cells of the superficial layers; and (3) contracting the small arteries and veins of the part, thus diminishing or even arresting the circulation within them, and preventing the escape of the plasma and blood-cells through their walls; whilst (4) the nerves are probably also depressed. These effects are called, as a whole, **astringent, antiphlogistic,** and **sedative.** The solutions of the subacetate are much employed as applications to ulcers, as injections for chronic inflammatory discharges from the vagina, urethra, ulcers, ear, etc., and as a collyrium for the conjunctiva; or the carbonate may be dusted upon ulcers, or used as ointment. The strong solution of the subacetate is a powerful irritant, causing pain and reaction, and is rarely used undiluted. The nitrate is stimulant or even caustic, and is applied to syphilitic onychia and chapped nipples. The iodide, in the form of the unguentum, may be rubbed into enlarged joints, glandular swellings and nodes, its absorptive effect being chiefly referable to the iodine.

Internally.—The local action of lead is first appreciated in the mouth as a peculiar "astringent taste," with a sharp sweetness in the case of the acetate. On the mucous membrane of the throat it acts as already described, coagulating the mucus, producing an astringent effect on the cells and vessels of the part, and causing a sensation of dryness. If inflammation be present it is rapidly controlled; and the subacetate, either painted on in the form of the strong solution, or as a gargle formed of the weak solution, is an efficacious remedy for tonsillitis.

The local action of lead on the stomach and intestine corresponds with what has been described: it diminishes the secretions, contracts the vessels, and arrests or retards the peristaltic movements; whilst it is itself converted into an albuminate by the fluids which it encounters. The acetate is accordingly given with or without opium to arrest hæmatemesis; and it is one of the most certain drugs in the treatment of obstinate diarrhœa, especially if ulceration be present, and hæmorrhage threatening, as in typhoid fever (where it may be advantageously combined with opium), and in tuberculosis of the bowels.

2. ACTION IN THE BLOOD.

Lead enters the blood as albuminate, but passes very rapidly through it, and cannot be found in it even after large doses. If lead be given for some time, the blood becomes more watery, and the red corpuscles fewer in number.

3. SPECIFIC ACTION.

All the tissues take up lead freely from the blood, and retain it obstinately as albuminate, the central nervous system being the important seat of its deposit, whilst it is even more abundant in the kidneys and liver as the channels of its escape, and in the bones from the sluggishness of their metabolism. Thus combined with the active cells of the body, lead after a time sets up a series of phenomena known as "plumbism." These are pathological, not physiological, effects, and may be briefly said to take the form of dyspepsia, constipation, and colic; a full, tense, and infrequent pulse, with increased cardiac action; disturbances of the urinary flow; neuralgic pains; tremors, followed by paralysis of the muscles, chiefly affecting the extensors of the wrist; anæmia and emaciation.

These symptoms and the results obtained by experiments on animals have been variously interpreted. Some authorities refer them to an irritant action of lead on the involuntary muscular fibres of the stomach, bowels, blood-vessels, similar to its astringent local effects, whence muscular contractions, painful spasms, narrowing of the vessels, and finally paralysis, and other phenomena from exhaustion. Other pharmacologists contend that lead acts primarily on the central nervous system and nerves, and secondarily only on the muscles, vessels, etc. Its remarkable effect in raising the blood pressure has been referred to irritation of the splanchnics, and consequent narrowing of the abdominal vessels; that is, to increased peripheral resistance. The increased blood pressure is the cause of the infrequent powerful cardiac action, and to some extent of the urinary disturbances.

4. SPECIFIC USES.

The specific action of lead is turned to many important uses. As a powerful **hæmostatic** it is used in bleeding from the stomach and bowel, as we have said, and also from the lungs, opium being advantageously combined with it to ensure mental and bodily rest (Pilula Plumbi cum Opio, or acetate of lead and acetate of morphia with acetic acid). Its use in diarrhœa is also partly referable to its specific action.

5. REMOTE LOCAL ACTION AND USES.

Lead is slowly excreted in the bile, urine, skin, and milk. In the bowel, the portion that has been excreted by the liver is reabsorbed, is again excreted, and finally escapes in the fæces as the black sulphide. In passing through the kidneys, lead diminishes the excretion of uric acid. It is used as a hæmostatic in renal hæmorrhage, in bronchorrhœa, and in profuse sweating.

6. ACTION AND USES OF THE DIFFERENT SALTS OF LEAD.

The special action and uses of the different preparations of lead are as follows: The *Acetate* is the only salt given internally. The solutions of the *Subacetate* are the only liquid preparations of the metal, and are used externally as lotions, injections, collyria, etc., as well as in the form of the ointment. The *Oxide* is made into *Emplastrum* plumbi, the basis of almost all plasters. The *Nitrate* is used as a local stimulant or escharotic, as described; and pharmaceutically to obtain the *Iodide.* The latter possesses, as already described, absorptive powers by virtue of the iodine, an effect which the lead probably promotes, *Plumbi Carbonas* is applied, either as the powder or as an ointment, for astringent purposes, to ulcers and inflamed surfaces.

ARGENTUM. 108. SILVER.

Two salts of this metal are officinal, the nitrate and the oxide.

Argentum Purificatum.—Refined Silver. Pure Metallic Silver.

Impurities.—Lead and copper.

From Argentum is made :

Argenti Nitras.—Nitrate of Silver. $AgNO_3$. Lunar Caustic.

Source.—Made by dissolving Silver in Diluted Nitric Acid.

Characters.—Colourless tabular right rhombic prisms, or white cylindrical rods. Solubility, 100 gr. in 50 min. of water.

Impurities.—Other nitrates; detected by evaporation of filtrate after precipitation with HCl.

Dose.—$\frac{1}{6}$ to $\frac{1}{3}$ gr.

From Argenti Nitras is made :

Argenti Oxidum.—Oxide of Silver. Ag_2O.

Source.—Made by precipitating a solution of Nitrate of Silver with Lime-Water—$2AgNO_3 + Ca2HO = Ag_2O + Ca2NO_3 + H_2O$.

Characters.—An olive-brown powder; insoluble in water. *Incompatible* with creasote, with which it forms an explosive substance.

Impurities.—Metallic silver, evolving gas with nitric acid.

Dose.—$\frac{1}{2}$ to 2 gr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—In the form of the solid pencil, nitrate of silver is a **caustic** causing destruction, with deep staining of the superficial layers, acute pain, inflammation of the deeper layers, separation of the part as a slough, and then rapid healing. Unlike potash, its effects are limited to the area of application. On this account it is the best caustic for ordinary use, to destroy the affected part in bites of dogs, serpents, and other venomous animals, in post-mortem wounds and chancres, or to remove small growths. Solutions of the nitrate, when applied to the broken skin or a mucous membrane, exert much the same action as lead, but in a greater degree: precipitating the albumins and the chlorides of the plasma or secretions; coagulating the protoplasm of the young cells of the part; causing active contraction of the arteries, veins, and capillaries; and very rapidly coagulating the blood both within and without them. Nitrate of silver is therefore the best local **antiphlogistic** known, controlling the exudation, growth, and vascular disturbance of the inflammatory process. It is employed to touch callous and weak ulcers, including bed-sores; to control local inflammations in accessible parts; and, as an injection, to wash inflamed surfaces, for example, the urethra, vagina, os uteri, bladder, and conjunctiva. A weak solution is used to harden the skin in threatening bed-sores. Solid caustic is an excellent **hæmostatic** on bleeding from leech-bites.

Internally.—In the mouth, silver causes a nauseous astringent metallic taste. Meeting with chlorides and albuminous fluids, it combines with these, and acts upon the surface of the mucous membrane as it does upon the skin. It is a useful remedy in inflammation of the tonsils and pharynx, whether applied in the solid form as an antiphlogistic in acute cases, or in solution as an **astringent** in relaxed, chronic states.

Reaching the stomach, nitrate of silver is decomposed by the hydrochloric acid and mucus, and cannot act as an irritant upon the mucous membrane unless given in poisonous doses. Its use in ulcers of the stomach must therefore be questioned. When given for ulceration of the bowels, it is administered *per rectum.*

2. ACTION IN THE BLOOD.

Silver enters the blood either as albuminate, or is absorbed as the pure metal by the intestinal epithelium and lacteals, after the manner of fat. It has no appreciable effect on the blood.

3. SPECIFIC ACTION AND USES.

Silver becomes locked up in all the connective tissues of the body, in the metallic form, staining exposed parts a dusky black brown, incapable of removal. It probably, therefore, remains inert within the body; but some authorities believe that it affects the nervous tissues, and recommend it in epilepsy, chorea, and locomotor ataxy. The permanent unsightly discoloration of the skin, which comes on after its use for several months, is a serious objection to its employment.

4. REMOTE LOCAL ACTION.

As we have just seen, silver once admitted to the tissues is not excreted. A certain amount has, however, been found in the urine; and a proportion always passes through the bowels unabsorbed, appearing on the fæces as sulphide. No use is made of these facts.

5. ACTION AND USES OF THE DIFFERENT SALTS OF SILVER.

The *Nitrate* is almost invariably used both externally and internally. The *Oxide* is less irritant, and is chiefly given internally in the form of pill.

CUPRUM. 63·5. COPPER.

The sulphate is the only salt of copper employed medicinally, although other compounds, as well as the metal itself, are introduced into the Pharmacopœia as tests.

1. Cupri Sulphas.—Sulphate of Copper. $CuSO_4.5H_2O$.

Source.—Made by heating Sulphuric Acid with Copper, dissolving the soluble product, evaporating and crystallising.

Characters.—A blue crystalline salt in oblique prisms. Solubility, 1 in 3 of water.

Impurity.—Iron.

Dose.—As an astringent or tonic, ¼ to 2 gr.; as an emetic, 5 to 10 gr.

From Cupri Sulphas is prepared:

Sulphate of Copper, Anhydrous. $CuSO_4$.—A yellowish-white powder made by heating sulphate of copper to 400° Fahr. Used in testing.

Copper wire is used for preparing Spiritus Ætheris Nitrosi.

2. Subacetate of Copper of Commerce. Verdigris. Œrugo. $(C_2H_3O_2)_2Cu,CuO$. In powder, or masses of very minute crystals of a bluish-green colour. Used in chemical testing.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION.

Externally.—The action of copper differs but little from that of silver and zinc. It does not affect the unbroken skin, nor is it absorbed by it into the blood. Applied freely to wounds, ulcers, or the delicate surface of exposed mucous membranes, such as the conjunctiva, the sulphate or "bluestone" is **caustic**, and is in frequent requisition to destroy warts, chancres and poisoned wounds, and for similar purposes. A swift and slight application of the crystal, or its solution in water, acts so far like nitrate of silver—precipitating the discharges from a mucous or ulcerated surface; coagulating the superficial layers; thus contracting the blood-vessels and arresting discharge. It is used as a **stimulant** to ulcers; and a solution of 2 to 5 gr. to the oz. may be used as an **astringent** lotion, or injected into the vagina, rectum, or urethra.

Internally.—The local action of copper on the mouth, beyond its astringent metallic taste, corresponds with that just described. If long administered, it may cause a greenish discoloration of the bases of the teeth (*not* of the gums) from direct combination with decomposing products there.

Sulphate of copper, in large doses (10 gr.), is not entirely converted into an albuminate in the stomach, but acts on the mucous membrane as an irritant, and causes vomiting. It is a rapid **direct emetic**, and is suited for administration when the stomach is to be surely and speedily emptied of a narcotic poison, such as opium, or the air-passages evacuated of mucus or false membrane, as in bronchitis and diphtheria, after ipecacuanha has failed. It causes less depression and subsequent nausea than tartar emetic. If sulphate of copper fail to vomit, it must be evacuated by some other means, otherwise dangerous inflammation may result.

Lastly, copper sulphate is a valuable antidote to phosphorus, as it is reduced by the metalloid, the copper being deposited upon the phosphorus and rendering it inert. In cases of poisoning by phosphorus, 3 gr. of blue-stone should be given in water every few minutes, until vomiting occurs, whereupon a free saline purgative is to be administered.

In the intestines copper is an **astringent** in small quantities, an irritant purgative in larger quantities. Small doses, combined usually with opium, are given for some kinds of diarrhœa.

2. ACTION IN THE BLOOD.

Given in small doses, copper is absorbed into the blood; but we neither know any effect that it produces here, nor use it in this connection.

3. SPECIFIC ACTION AND USES.

The specific action of copper on the tissues is most difficult to evoke, as anyone can testify who has watched a large number of persons working in brass and copper. It is said to weaken the voluntary muscles and heart, and to affect the nutrition of the central nervous system; whence it was formerly used in convulsions and spasmodic diseases, including epilepsy, chorea, and hysteria. This treatment is now almost obsolete. It is believed by some to be a specific astringent to the uterus.

4. REMOTE LOCAL ACTION.

Copper is chiefly excreted by the liver, that is, leaves the body with the bile and fæces; part is discharged in the urine, and part by the saliva. No special advantage is taken of its elimination by these channels.

ZINCUM. ZINC. 65.

Zincum Granulatum.—Made by pouring fused zinc into cold water.

From Zincum Granulatum are made:

a. **Zinci Chloridum.**—Chloride of Zinc. $ZnCl_2$.

Source.—Made by dissolving Zinc in Diluted Hydrochloric Acid, and evaporating; Chlorine Water and Carbonate of Zinc being used in the process, to precipitate iron or tin present as impurities.

Characters.—Colourless rods or tablets, very deliquescent, and caustic. Solubility, 10 in 4 of water, freely in rectified spirit and ether.

Impurities.—Sulphates, iron, and calcium.

b. **Liquor Zinci Chloridi.**

Source.—Made as above, without evaporation.

Characters.—Colourless. Used externally only.

c. **Zinci Sulphas.**—Sulphate of Zinc. $ZnSO_4,7H_2O$.

Source.—Made from Zinc and Sulphuric Acid, like the Chloride, with the same precautions.

Characters.—Colourless prisms, with a metallic styptic taste.

Impurities.—Iron, lead, copper, arsenic.

Dose.—1 to 3 gr. as a tonic; 10 to 30 gr. as an emetic.

From Zinci Sulphas are made :

a. **Zinci Carbonas.** — Carbonate of Zinc. $ZnCO_3(ZnO)_2 3H_2O$. "Calamine."

Source.—Made by decomposing a solution of Sulphate of Zinc with a solution of Carbonate of Soda. (1) $ZnSO_4 + Na_2CO_3 = ZnCO_3 + Na_2SO_4$. (2) $3ZnCO_3 + 3H_2O = ZnCO_3 2(ZnO),3H_2O + 2CO_2$.

Characters. — A white, tasteless, inodorous powder, insoluble in water; an impure carbonate.

Impurities.—Sulphates, chlorides, copper.

From Zinci Carbonas are made :

(i) **Zinci Oxidum.**—Oxide of Zinc. ZnO.

Source.—Made by heating the Carbonate.

Characters.—A soft, nearly white, tasteless, and inodorous powder, insoluble in water.

Impurities. — The carbonate; effervescing with acids. And its impurities.

Dose.—2 to 10 gr.

Preparation.

Unguentum Zinci Oxidi.—80 gr. to 1 oz. Benzoated Lard.

(ii) **Zinci Acetas.** — Acetate of Zinc. $Zn(C_2H_3O_2)_2.2H_2O$.

Source.—Made by dissolving Carbonate of Zinc in Acetic Acid and Water, and crystallising. $ZnCO_3,2ZnO.3H_2O + 6C_2H_4O_2 = 3(Zn2C_2H_3O_2) + 6H_2O + CO_2$.

Characters. — Thin colourless crystalline plates, of a pearly lustre, with sharp, unpleasant taste. Solubility, 10 in 25 of water.

Impurities.—Those of the carbonate.

Dose.—1 to 2 gr. as tonic; 10 to 20 gr. as an emetic.

Zinci Carbonas is also used in making Zinci Chloridum and Zinci Sulphas.

β. **Zinci Valerianas.**—Valerianate of Zinc. $Zn(C_5H_9O_2)_2$.

Source.—Made by mixing solutions of Sulphate of Zinc and Valerianate of Soda, and crystallising.

Characters.—Brilliant white, pearly, tabular crystals, with an odour of valerianic acid, and a metallic taste. Solubility, 1 in 120 of water; 1 in 60 of spirit.

Impurities.—Sulphate and butyrate of zinc.

Dose.—1 to 3 gr.

Non-officinal Preparations of Zinc.

Calamina Præparata.—Calamine. Impure Oxide of Zinc, obtained by calcining native Carbonate of Zinc, and reducing it to an impalpable powder. A greyish or flesh-coloured powder.

Oleate of Zinc.—Made by heating Oxide of Zinc with Oleic Acid. 1 to 8.

Incompatibles of Zinc Salts in general.

Alkalies and their carbonates, lime-water, acetate of lead, nitrate of silver, astringent vegetable infusions or decoctions, and milk.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—The salts of zinc closely resemble in their action the salts of lead, silver, and copper, being **caustic** in their stronger forms, **astringent** or **antiphlogistic** in their weaker forms. Zinc presents every degree of this action, according to the salt employed, that is probably according to the solubility and diffusion-power of the particular combination of the metal. Thus the chloride, which is highly deliquescent, penetrates the tissues, and is a powerful escharotic, causing destruction of the part, with severe pain, separation of a slough, and subsequent healing. It is employed to destroy morbid growths, chronic ulcers, and gangrenous parts, in the form of a paste or of solid arrows made with plaster of Paris or flour, or as a strong solution. The sulphate and acetate have less affinity for water, and are much less powerful than the chloride. When applied to the broken skin, an ulcer, or an exposed mucous surface, they precipitate the albuminous juices or secretions, coagulate the protoplasm of the upper layers of growing cells, and indirectly cause contraction of the vessels, though less than silver and lead. The sulphate of zinc is the most common of all applications for healing ulcers and wounds, limiting the amount of discharge, checking excessive or "weak" growth, and modifying the intensity of the inflammatory process with which the healing is associated. A solution of this salt is the basis of the ordinary "red lotion" of many hospital pharmacopœias; and other weak solutions of the same may be employed as a wash or injection for the eyes, urethra, vagina, and other accessible mucous tracts. The oxide and carbonate of zinc, and calamine, act locally as mild astringents in inflamed conditions of the superficial layers of the skin, such as eczema, controlling exudation and hyperæmia, and protecting the parts from the air. Being insoluble in water, they are applied in the form either of powder or of the ointment.

Internally, the local action of zinc corresponds. It is but little used in the mouth or throat, but its effect on the stomach as a local irritant furnishes us with the most familiar of our **direct emetics.** Sulphate of zinc, in doses of 20 grains, causes rapid and complete vomiting, attended by less immediate depression and less subsequent nausea than antimony and ipecacuan. It is much employed in narcotic poisoning; more rarely in croup, diphtheria, and phthisis, to clear the air passages; or even to empty the stomach in painful dyspepsia. The oxide on reaching the stomach is dissolved, and acts like the soluble salts of zinc.

In the intestine the irritant action of zinc is continued, if it be given in large doses, but this effect is never desired therapeutically. On the contrary, the oxide, in sufficient doses to relieve a moderate superficial catarrh, is often a very efficacious **astringent** in the treatment of diarrhœa in children.

2. ACTION IN THE BLOOD.

Zinc readily enters the circulation, but nothing is known respecting its influence on the plasma or corpuscles which can be turned to therapeutical account.

3. SPECIFIC ACTION AND USES.

The action of zinc upon the tissues has been learned chiefly from its effect in certain diseased conditions in man, and is but imperfectly understood. It appears to be a **depressant** to the nervous and muscular systems, and has been employed with unquestionable success in epilepsy, chorea, and whooping cough, all of which are characterised by nervo-muscular excitement. Observations on animals, in which the irritability of the voluntary and cardiac muscles is found to be decidedly reduced by zinc, confirm this experience.

4. REMOTE LOCAL ACTION AND USES.

The kidneys and mammary gland, and probably the mucous surfaces and skin, are the channels of elimination of zinc. It is possible that the metal exerts a second or remote **astringent** effect on these parts as it is leaving the system; for the sulphate and oxide appear to have the power of arresting chronic discharges from remote mucous passages, such as the uterus and vagina, even when given internally; and it is certain that the oxide diminishes the perspirations of phthisis in some instances.

5. ACTIONS AND USES OF THE DIFFERENT SALTS OF ZINC.

These have been sufficiently indicated in the preceding description. The *Chloride* stands alone as a powerful escharotic, never to be given internally; it possesses also disinfectant properties, as the *Liquor Zinci Chloridi*, which is used to mop out very foul wounds, and very extensively to wash infected rooms, flush drains, etc. The *Sulphate* and *Acetate* closely resemble each other in their action, but the acetate is little used. The *Oxide* and *Carbonate* are similarly allied to each other, the former being generally employed. *Zinci Valerianas* probably acts as a zinc salt only, the valerianic acid appearing to be inert. See *Valerianæ Radix.*

CADMIUM. CADMIUM. Cd. 112.

Cadmii Iodidum.—Iodide of Cadmium. CdI_2.

Source.—Made by direct combination of Iodine and Cadmium in the presence of Water.

Characters.—Flat white micaceous crystals, of a pearly lustre. Solubility, 1 in 1½ of water.

Impurity.—Zinc, and general impurities.

Preparation.

Unguentum Cadmii Iodidi.—1 in 8.

ACTION AND USES.

Cadmium closely resembles zinc in its action, both locally and specifically, but is even more **irritant**, and is not given internally. The iodide, in the form of the ointment or in aqueous solution, is applied as a **local stimulant** to enlarged joints and glands, to promote absorption, instead of the iodide of lead which stains the skin yellow.

CERIUM. Ce. 92.

Only one salt of this metal is officinal.

Cerii Oxalas.—Oxalate of Cerium. $CeC_2O_43H_2O$.

Source.—Made by precipitating a solution of Oxalate of Ammonia with a soluble salt of Cerium.

Characters.—A white granular powder; insoluble in water.

Impurities.—Alumina; detected by its solution in potash giving precipitate with NH_4Cl. Other oxalates, the ash of which gives effervescence with boiling HCl.

Dose.—1 to 2 gr.

ACTION AND USES.

Nothing is definitely known about the physiological action of cerium. It is given with benefit in **vomiting,** acid dyspepsia, and heartburn, especially when they occur in pregnancy; and has been credited with good effects in chronic nervous diseases such as epilepsy and chorea.

FERRUM. IRON. Fe = 56.

Wrought-iron in the form of wire or nails free from oxide. Iron wire No. 35.

Preparations.

1. Mistura Ferri Aromatica.—Iron Wire, 2, Pale Cinchona Bark, 4; Calumba, 2; Cloves, 1; Compound Tincture of Cardamoms, 12; Tincture of Orange Peel, 2; and Peppermint Water, 50.

Dose.—1 to 2 fl.oz.

2. Vinum Ferri.—Iron wire digested in Sherry, 1 in 20

Dose.—1 to 4 fl.dr.

From Ferrum are also made:

3. Ferri Sulphas.—Sulphate of Iron. $FeSO_4.7H_2O$.

Source.—Made by dissolving Iron Wire in Sulphuric Acid and Water, and crystallising.

Characters.—Pale green rhombic prisms, with a styptic taste. Solubility, 1 in $1\frac{1}{2}$ of water; insoluble in spirit.

Impurities.—Persalts, giving sediment in aqueous solution. Copper, precipitated by H_2S.

Dose.—1 to 5 gr.

Preparations.

From Ferri Sulphas are made:

a. **Ferri Sulphas Exsiccata.** $FeSo_4.H_2O$.—A dirty white powder, made by heating the Sulphate.

Dose.—$\frac{1}{2}$ to 3 gr.

b. **Ferri Carbonas Saccharata.**—37 per cent. of Carbonate of Iron, $FeCO_3$, mixed with Peroxide of Iron and Sugar.

Source.—Made by precipitating a solution of Sulphate of Iron with Carbonate of Ammonia, and rubbing with Sugar. (1) $FeSO_4 + (NH_4)_2CO_3 = FeCO_3 + (NH_4)_2SO_4$. (2) $3FeCO_3 + O = FeCO_3 + Fe_2O_3 + 2CO_2$. The sugar prevents oxydation.

Characters.—Grey-brown lumps, with a sweet chalybeate taste.

Impurities.—Sulphate of ammonia and oxide of iron.

Dose.—5 to 20 gr.

Preparation.

Pilula Ferri Carbonatis.—4 to 1 of Confectio Rosæ.

Dose.—5 to 10 gr.

c. **Mistura Ferri Composita.**—"Griffiths' Mixture."

Sulphate of Iron, 25 gr.; Carbonate of Potash, 30 gr.; Myrrh, 60 gr.; Sugar, 60 gr.; Spirit of Nutmeg, 4 fl.dr.; Rose Water, 9 fl.oz. *Dose,* 1 to 2 fl.oz.

d. **Ferri Arsenias.**—Arseniate of Iron. $Fe_3As_2O_8$.

Source.—Made by precipitating a mixed solution of Arseniate and Acetate of Soda with Sulphate of Iron; and washing. $3FeSO_4 + 2Na_2AsO_4 + 2NaC_2H_3O_2 = Fe_3As_2O_8 + 3Na_2SO_4 + 2C_2H_4O_2$.

Characters.—A green amorphous powder, tasteless (but not to be tasted), insoluble in water.

Impurities.—Sulphates, and general impurities.

Dose.—$\frac{1}{16}$ to $\frac{1}{2}$ gr. in pill.

e. **Ferri Phosphas.**—Phosphate of Iron. $Fe_3P_2O_8$.

Source.—Made by precipitating a mixed solution of Phosphate and Acetate of Soda with Sulphate of Iron. $3FeSO_4 + 2Na_2HPO_4 + 2NaC_2H_3O_2 = Fe_3P_2O_8 + 3Na_2SO_4 + 2C_2H_4O_2$.

Characters.—A slate-blue amorphous powder, insoluble in water.

Impurity.—Arsenic; detected by Reinsch's test.

Dose.—5 to 10 gr.

f. **Ferri Persulphatis Liquor.**

Source.—Made by boiling nitric acid and water with a hot solution of sulphate of iron in sulphuric acid and water. $6(FeSO_4) + 3(H_2SO_4) + 2HNO_3 = 3(Fe_2 3SO_4)$

$+ 4H_2O + 2NO$. Introduced only for making several preparations.

Characters.—Dark brown, inodorous and astringent.

From Liquor Ferri Persulphatis are made :

α. **Ferri Oxidum Magneticum.**—Magnetic Oxide of Iron. Fe_3O_4, with some peroxides.

Sources.—Made by precipitating a solution of the Proto- and Persulphates of Iron with a Solution of Soda, and drying. (1) $FeSO_4 + Fe_2 3SO_4 + 8NaHO = Fe2HO + Fe_2 6HO + 4Na_2SO_4$. (2) $Fe2HO + Fe_2 6HO = Fe_3O_4.4H_2O$.

Characters.—A brownish-black tasteless powder.

Impurity.—Metallic iron; detected by effervescing with HCl.

Dose.—5 to 10 gr.

β. **Ferri Peroxidum Humidum.**—Moist Peroxide of Iron. $Fe_2.6HO$.

Source.—Made by precipitating Solution of Persulphate of Iron with Solution of Soda. $Fe_2 3SO_4 + 6NaHO = Fe_2 6HO + 3Na_2SO_4$.

Characters.—A soft reddish-brown mass.

Impurities.—Ferrous hydrate. Ferric oxyhydrate; insoluble in cold HCl.

Dose.—$\frac{1}{4}$ to $\frac{1}{2}$ oz.

From Ferri Peroxidum Humidum is made :

Ferri Peroxidum Hydratum.—Hydrated Peroxide of Iron. $Fe_2O_2 2HO$. Made by drying the Moist Peroxide. A reddish-brown powder, without taste. *Dose*, 5 to 30 gr.

Impurities.—Ferrous hydrate.

Preparation.

Emplastrum Ferri. — "Emplastrum Roborans." 1 in 11.

From Ferri Peroxidum Hydratum is made :

Ferrum Redactum. — Reduced Iron. Metallic iron, with a variable amount of Magnetic Oxide.

Source.—Made by passing dry Hydrogen over the Hydrated Peroxide.

Characters.—A fine greyish-black powder.

Impurity.—Excess of oxide; detected volumetrically.

Dose.—1 to 5 gr.

Preparation.

Trochisci Ferri Redacti.—1 gr. in each.

γ. **Ferri et Ammoniæ Citras.**—Citrate of Iron and Ammonia.

Source.—Made by dissolving Hydrated Peroxide of Iron (freshly prepared from the Solution of the Persulphate by Ammonia) in a hot solution of Citric Acid, neutralising with Ammonia, and evaporating.

Characters.—Deep red scales, deliquescent; slightly sweet and astringent in taste. Solubility, 10 in 5 of water, almost insoluble in rectified spirit.

Impurities.—Tartrates; giving crystalline precipitate with acetic acid. Alkaline salts; detected in ash.

Dose.—5 to 10 gr.

Preparation.

Vinum Ferri Citratis.—1 gr. in 1 fl.dr. of orange wine. *Dose,* 1 to 4 fl.dr.

δ. **Ferri et Quiniæ Citras.**—Citrate of Iron and Quinia.

Source.—Made like Ferri et Ammoniæ Citras, freshly precipitated Quinia being also dissolved in the Citric Acid solution.

Characters.—Greenish-yellow scales, deliquescent, bitter and chalybeate in taste. Solubility, 2 in 1 of water. 6 gr. contain 1 grain of quinia.

Impurities.—Alkaline salts; detected in ash. Other alkaloids instead of quinia; insoluble in ether when precipitated by NH_4HO.

Dose.—5 to 10 gr.

ε. **Ferrum Tartaratum.**—Tartarated Iron.

Source.—Made like Ferri et Ammoniæ Citras with Acid Tartrate of Potash instead of Citric Acid.

Characters.—Garnet scales. Solubility, 1 in 4 of water; sparingly in spirit.

Impurities.—Ammonia; evolved by boiling with liquor sodæ. Ferrous salts.

Dose.—5 to 10 gr.

ζ. **Tinctura Ferri Acetatis.** — Tincture of Acetate of Iron.

Source.—Made by adding Acetate of Potash and Rectified Spirit to the Solution of the Persulphate, and filtering. $Fe_2 3SO_4 + 6KC_2H_3O_2 = Fe_2 6C_2H_3O_2 + 3K_2SO_4$.

Characters.—A deep brown liquid.

Dose.—5 to 30 min.

4. Ferri Sulphas Granulata.—Granulated Sulphate of Iron. $FeSO_4.7H_2O$.

Source.—Made by pouring a solution of Iron Wire in Diluted Sulphuric Acid into Rectified Spirit, stirring the mixture; and drying.

Characters.—Small, pale green granular crystals. Solubility, 1 in $1\frac{1}{2}$ of water, insoluble in spirit.

Impurities.—Same as of Ferri Sulphas.

Dose.—1 to 5 gr.

Preparation.

Syrupus Ferri Phosphatis.—1 gr. of Ferri Phosphas in 1 fl.dr.

Source.—Made by precipitating a solution of Granulated Sulphate of Iron with a mixed solution of Phosphate and Acetate of Soda, dissolving the precipitate in Diluted Phosphoric Acid, and adding Sugar.

Characters.—Colourless, becoming brown. 1 fl.dr. contains 1 gr. of Ferri Phosphas ($Fe_3P_2O_8$).

Dose.—1 to 4 fl.dr.

5. Ferri Iodidum.—Iodide of Iron. FeI_2.

Source.—Made by boiling Iron Wire and Iodine in Water, and evaporating.

Characters.—Crystalline, green with a tinge of brown, inodorous, deliquescent. Consists of iron, 1; iodine, $4\frac{1}{2}$; water, $1\frac{1}{4}$. Solubility, 1 in 1 of water.

Dose.—1 to 5 gr.

6. Pilula Ferri Iodidi.—Made by mixing a solution of Iron Wire and Iodine in Water, with Sugar and Liquorice. 1 in $3\frac{1}{2}$. *Dose*, 3 to 8 gr.

7. Syrupus Ferri Iodidi.—Made by mixing a solution of Iron Wire and Iodine in Water with Syrup. Colourless. 4·3 gr. in 1 fl.dr. *Dose*, 20 to 60 min.

8. Ferri Perchloridi, Liquor Fortior.—Strong Solution of Perchloride of Iron.

Source.—Made by adding Hydrochloric Acid and Nitric Acid to a hot solution of Iron Wire in Hydrochloric Acid and Water (1) $Fe + 2HCl = FeCl_2 + H_2$. (2) $6FeCl_2 + 6HCl + 2HNO_3 = 3Fe_2Cl_6 + 4H_2O + 2NO$.

Characters.—An orange-brown liquid, consisting of perchloride of iron, Fe_2Cl_6, in solution in water. Not given internally.

Impurities.—Ferrous salts.

Preparations.

a. **Liquor Ferri Perchloridi.**—Pale brown. 1 to 3 of water. *Dose,* 10 to 30 min.

b. **Tinctura Ferri Perchloridi.**—Light brown. 1 to 3 of spirit. *Dose,* 10 to 30 min.

9. Liquor Ferri Pernitratis.—Solution of Pernitrate of Iron.

Source.—Made by dissolving Iron Wire in Diluted Nitric Acid.

Characters.—A clear reddish-brown liquid, slightly acid and astringent to the taste; consisting of pernitrate of iron, $Fe_2 6NO_3$, in solution in water.

Impurities.—Ferrous salts.

Dose.—10 to 40 min.

Incompatibilities of Preparations of Iron in General.

Alkalies and their carbonates, lime-water, carbonate of lime, magnesia, and its carbonate, give green precipitates with proto-salts, brown with persalts. Tannic and gallic acids give a deep blue-black with persalts. Preparations of iron therefore tinge infusion of chiretta and hops, and change to brown or black those of chamomile, cusparia, gentian, orange, cascarilla, cloves, digitalis, cinchona, and all astringent infusions; but they can be given in infusion of quassia or calumba.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—A solution of iron has a corrugating and **astringent** effect upon the broken skin and mucous surfaces, coagulating the albuminous tissues and plasma, and constringing or condensing the elements. The blood-vessels are thus closed or diminished in size, not actively, but by compression from without; the circulation through them is diminished; hæmorrhage, if present, is arrested; and the abnormal escape of plasma and leucocytes, which characterises chronic inflammation or catarrh, is checked. Solutions of the ferric salts are therefore used as **hæmostatics** to arrest hæmorrhage from accessible parts, such as leech-bites, the nose, and uterus; less extensively in chronic discharges from the vagina, rectum, and nose, as astringents. Injected into the rectum, they destroy worms. Iron is not absorbed by the unbroken skin.

Internally.—The constringent effect of iron is appreciated in the mouth as a "styptic taste." Beyond this, the local action corresponds with that just described externally. Various iron solutions are usefully applied, either as gargles or with the brush, in some forms of chronic sore throat.

In the stomach all the salts of iron, whatever their nature, are converted into the chloride, and do not combine with the acid albuminates, like some of the other metals. Deficiency of hydrochloric acid or of food, or excess of iron, thus decomposes the gastric juice, and allows the iron to act upon the mucous membrane as an astringent and irritant. Iron is thus directly **unfavourable to digestion**; and in this connection we must carefully note (1) that iron may disorder the digestion even in healthy subjects; (2) that it must not be given for disease until the gastric functions have been so far restored; (3) that it is well to begin then with the mildest preparations; and (4) that it must be given after meals. Iron is a valuable **antidote** in arsenical poisoning, the humid peroxide ($Fe_2 6HO$) forming with arsenious acid an almost insoluble compound ($As_2O_3 + 2(Fe_2 6HO) = Fe_3As_2O_8 + Fe2HO + 5H_2O$). Abundance of the iron should be given, and the compound should be quickly expelled by a smart purge of sulphate of magnesia or soda. The solutions of the persalts are used to arrest hæmorrhage from the stomach. In the duodenum iron is converted into an alkaline albuminate, and thus absorbed. The further effect of iron on the bowel is a remote one, to be presently described.

2. ACTION ON THE BLOOD, AND ITS USES.

The action of iron on the blood is almost unique of its kind: first, because its specific action is exerted, not upon the plasma, but upon the red corpuscle, and on this alone, not on any other tissue or organ; secondly, because this action appears to be nothing more than the combination of the iron as one of the constituent elements of the corpuscle with the others. In the case of no other metal can we speak so definitely of its *modus operandi*.

Iron enters the circulation along the whole length of the alimentary canal as the chloride and alkaline albuminate, and quickly unites with the corpuscles, as it cannot be found in the plasma. It combines with the hæmoglobin, and as such alone exists in the blood. In normal blood a "course" of iron increases the richness of the blood; whilst in anæmia the rapidity of the growth of corpuscles and of the rise in value of the hæmoglobin, as estimated day by day with the hæmoglobinometer and hæmacytometer, is remarkable. Iron is accordingly used as a **hæmatinic** in an endless variety of conditions in which hæmoglobin is deficient, such as simple anæmia, scrofula, amenorrhœa, cardiac disease, syphilis, malarial cachexia, and convalescence from acute disease. The cautions already given respecting digestion must be faithfully respected, to secure its hæmatinic action over a length of time. Iron is an important constituent of many well-known mineral waters, the most important being those of Spa, Tarasp, Kissingen, Kreutznach, Pyrmont, and St. Moritz on the Continent; Harrogate, Moffat, and Strathpeffer in this country; and the Rawley Springs, Sweet Chalybeate, and Bedford, in the United States.

3. SPECIFIC ACTION AND USES.

Iron has no specific action on the organs apart from the blood; and the **tonic** effect which it produces so satisfactorily, appears to be entirely referable to its action on the blood. Abundance of oxygen is essential for every bodily and mental function; and the feeling of "tone," vigour, and mental fitness varies with the degree of oxygenation of the blood, *i.e.* with the quality of the blood as regards hæmoglobin. Nervous, muscular, and cardiac debility are thus removed by iron, and even digestion is restored by this gastric irritant, if it can be successfully introduced into the blood. The temperature is said to be slightly raised by iron, showing increased oxydation. Iron has also a specific effect in erysipelas, diphtheria, and other adynamic diseases, which cannot be perfectly explained. Fever is generally held to contraindicate the use of iron; and the same may be said of phthisis, except as mild forms in chronic cases.

4. REMOTE LOCAL ACTION AND USES.

Iron is excreted by almost every possible channel. As it is absorbed, so a portion of it is excreted, along the whole length of the intestine, and colours the fæces black (sulphide). Only a small amount escapes in the urine, saliva, sweat, the milk in women, the pancreatic juice, and by the various mucous surfaces. Whilst passing out of the system, iron produces a second or **remote** effect of an **astringent** kind. As regards the bowels, the clinical applications of this action are most important. Thus most of the salts of iron cause constipation unless combined with a purgative, such as the sulphates of magnesia and soda, or aloes; no good can be derived from iron until the bowels have been thoroughly relieved, and are acting regularly; and certain salts, such as the perchloride and pernitrate, which are more astringent to the intestines than others, may sometimes be employed to check chronic diarrhœa and dysentery, and to arrest hæmorrhage from the bowel in typhoid fever. The remote astringent action of iron is increased from the fact that it is also excreted by the liver, and passes down with the bile. The urine falls somewhat in volume, but the urea and other solids, as well as the acidity, are increased. Hæmorrhage from the kidney or bladder is arrested by iron, which is also beneficial in some cases of Bright's disease.

Iron similarly reduces the secretion of milk in nursing women. The remote effect of iron on the mucous surfaces renders it a valuable hæmostatic in recurrent passive bleedings from the nose, uterus, and respiratory passages. As a remote astringent, it is invaluable in chronic discharges from the same and allied parts, especially in leucorrhœa.

5. ACTIONS AND USES OF THE DIFFERENT PREPARATIONS OF IRON.

Large as is the number of the preparations of iron, they and their special actions may be easily remembered if classified as follows:

1. **Iron, its Oxides and Carbonates.**—This group comprises Ferrum Redactum, Mistura Ferri Aromatica, Vinum Ferri, Ferri Carbonas Saccharata, Mistura Ferri Composita, Ferri Peroxidum Hydratum, and Ferri Peroxidum Magneticum. These preparations possess the hæmatinic action of iron with but little astringency, and are accordingly selected to restore the blood, when the patient has a tendency to dyspepsia and constipation. They are the principal forms of iron used in the routine treatment of anæmia, amenorrhœa, and chlorosis in young women. Let it be observed that these solid preparations form the soluble compounds in the stomach, for absorption into the blood, as readily as do the fluid preparations belonging to the second class. The Mistura Ferri Composita, although a preparation of the protosulphate, contains the carbonate and peroxide, and is a favourite and valuable preparation for anæmia with amenorrhœa; the iron acting as a hæmatinic, the potash also building up the red corpuscle (the salts of which are almost entirely potassium compounds), and the myrrh possibly increasing the production of leucocytes for conversion into the red, as well as stimulating the uterus. Ferrum Redactum, the Saccharated Carbonate and the Hydrated and Magnetic Oxides, although bulky powders, are easily taken. Vinum Ferri is an agreeable

preparation largely prescribed for children. The Aromatic Mixture, containing cinchona and aromatic bitters, is a valuable stomachic tonic and hæmatinic.

2. **Compounds of Iron with the Mineral Acids.**—Ferri Sulphas in its various forms, Liquor Ferri Perchloridi and its preparations, and Liquor Ferri Pernitratis, are comprised in this group, which are characterised by their corrugating and astringent action. They are, therefore, chosen in all the external and internal applications of iron for local purposes, especially as hæmostatics. The strong solution of the perchloride is injected into the uterus in *post partum* hæmorrhage in the form of a watery solution (1 part to 3) with the best results. Cotton wool or lint soaked in the same solution is used for plugging deep wounds, the cavities of the nose, mouth, etc., in hæmorrhage; but the action of the iron on the surfaces of wounds, and the extensive coagulation which it sets up in the veins, are both objections to its employment, unless the bleeding cannot otherwise be arrested. Internally these astringent preparations may be given in hæmorrhage from the stomach or bowels, kidneys or bladder; but not, as a rule, in hæmoptysis. As hæmatinics, the tincture or liquor of the perchloride and the pernitrate, well diluted, are much given to convalescents after the appetite has been restored, and to persons who require a tonic, as well as in passive hæmorrhages and chronic inflammatory discharges, such as leucorrhœa. In ordering this class of iron salts, we must carefully observe the various precautions already mentioned in connection with digestion. Protosulphate is well borne in the form of pill (Blaud).

3. **Compounds of Iron with Vegetable Acids.**—These are the Ferri et Ammoniæ Citras, Ferrum Tartaratum, and Tinctura Ferri Acetatis. They are at once the weakest, the blandest, and the least constipating preparations of iron, and are therefore employed when only small quantities of the metal have to be given over a length of time as a tonic, or to commence a course of hæmatinics when the alimentary canal cannot tolerate the stronger preparations. They make but little impression upon the more severe forms of anæmia. They can be given with alkalies.

4. **Compounds of Iron with other active bodies.**—Iron is combined in the Pharmacopœia with iodine—Ferri Iodidum; with arsenic acid—Ferri Arsenias; with phosphoric acid—Ferri Phosphas; and with quinine—Ferri et Quiniæ Citras. Speaking generally, it may be said that in these preparations the iron is intended to relieve anæmia, or to act as a tonic in the sense we have described, whilst the other constituent is specifically influencing the diseased condition on which the anæmia or

debility depends. Thus the iodide of iron is employed in syphilis and scrofula; the arseniate in chronic diseases of the skin, liver, etc., with a gouty, rheumatic, or malarial taint; the phosphate in diseases of the bones, such as rickets; and the compound with quinine in malarial cachexia, where it may rapidly restore the blood corpuscles. But all the preparations of this group, and especially the last, are also used as ordinary tonics, according to circumstances.

The Solution of the Persulphate of Iron is introduced solely as a source of several other preparations. Ferri Peroxidum Humidum is the best form as an antidote to arsenic, the *rationale* of which has been already explained.

MANGANESIUM. Mn. MANGANESE.

The only salt of this metal in the Pharmacopœia is the black oxide; but permanganate of potash, which is derived from it, is best discussed under this head.

Manganesii Oxidum Nigrum.—Black Oxide of Manganese. MnO_2. A heavy black powder.

From Manganesii Oxidum Nigrum is made:

Potassæ Permanganas.—Permanganate of Potash. $KMnO_4$.

Source.—Made by (1) evaporating a mixture of Black Oxide of Manganese, Chlorate of Potash, and Caustic Potash in water, pulverising the residue, heating it to redness, cooling and pulverising; then (2) boiling in Water, neutralising with Diluted Sulphuric Acid, and evaporating. (1) $3MnO_2 + KClO_3 + 6KHO = 3K_2MnO_4 + KCl + 3H_2O$; a manganate being formed. (2) $3K_2MnO_4 + 2H_2O = 2KMnO_4 + 4KHO + MnO_2$; the manganate becoming permanganate by boiling.

Characters.—Dark purple, slender prisms, inodorous, with a sweet astringent taste, yielding an intense purple solution when moistened. Solubility, 1 in 16 of water. Is very rapidly deoxydised in the presence of organic matter into hydrated peroxide of manganese, losing its purple colour for a brown.

Impurities.—Sulphate of potash, and black oxide of manganese; detected by being less soluble in water, and by volumetric test.

Dose.—1 to 2 gr.

Preparation.

Liquor Potassæ Permanganatis.—4 gr. to 1 fl.oz. *Dose*, 2 to 4 fl.dr.

Manganesii Oxidum Nigrum is also used in making Liquor Chlori and Hydrargyri Perchloridum.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Permanganate of potash is an irritant or even escharotic in the pure state, stimulant in the form of the solution, and has a healing effect upon sears and wounds. The principal applications, however, are independent of its physiological action on the human tissues, and due to its influence as an **antiseptic, disinfectant,** and **deodorant,** that is, to its action on the processes and products of sepsis, fermentation, and decomposition. By its power of giving up oxygen freely, the permanganate either destroys the ferment or organism on which these processes depend, or forms chemical compounds with the materials on which they flourish (the tissues, plasma, pus, etc.), incapable of decomposition: it is thus an *antiseptic.* By similarly oxydising the products of decomposition already begun, it so alters their chemical properties as to deodorise and decolorise them, and possibly destroys also the power of further infection which such products generally possess: it is thus a *disinfectant.* Permanganate of potash may therefore be used as a dressing for foul ulcers; but other substances, possessing special advantages, are generally preferred for this purpose.

Internally.—This salt is employed as a mouth-wash in foul condition of the teeth and mouth, as a gargle in putrid sore-throat, and as an injection in infective and foul discharges, such as gonorrhœa, vaginitis, ozœna, and cancer of the uterus.

2. ACTION IN THE BLOOD, SPECIFIC ACTION, AND REMOTE LOCAL ACTION.

Nothing is definitely known of the action of permanganic acid on the blood, tissues, or organs of excretion. It is difficult to believe that any portion of the salt escapes decomposition before absorption, unless given in poisonous doses; and the oxide of manganese, into which it is converted, is believed to be inert. The internal administration of the potash salt for some supposed effect on infective fevers or gangrenous processes must therefore be useless. It has recently been used as an emmenagogue in amenorrhœa.

By far the most important application of permanganate of potash is as a disinfectant and deodorant, apart from the human body: to disinfect stools and foul discharges after removal from the patient; to wash utensils; and to flush water-closets, etc. Its great advantages are, that it is rapid and complete in its action; odourless and non-poisonous in solutions of ordinary strength; and that it shows by change of colour whether it is acting or exhausted. The principal disadvantage connected with it is its expense.

HYDRARGYRUM. Hg. 200. MERCURY.

This metal is of the first therapeutical importance, and a large number of salts and other preparations are made from it.

Hydrargyrum.—Mercury. Hg.
Characters.—A fluid metal, brilliantly lustrous.
Impurities.—Lead, tin, etc.; detected by being non-volatile.

Preparations.

a. **Hydrargryum cum Cretâ.**—1, with 2 of Chalk. *Dose*, 3 to 8 gr.

b. **Emplastrum Hydrargyri.**—1 in 3.

c. **Emplastrum Ammoniaci cum Hydrargyro.**—1 in 5.

d. **Pilula Hydrargyri.**—"Blue Pill." 1 in 3, with Confection of Roses and Liquorice. *Dose*, 3 to 8 gr.

e. **Unguentum Hydrargyri.**—"Blue Ointment." Nearly 1 in 2.

From Unguentum Hydrargyri are prepared:

α. Linimentum Hydrargyri.—1 of Ointment, to 1 of Liquor Ammoniæ, and 1 of Linimentum Camphoræ.

β. Unguentum Hydrargyri Compositum.—6, with 7½ Olive Oil, Wax, and Camphor.

γ. Suppositoria Hydrargyri.—5 gr. of ointment in each.

From Hydrargyrum are made:

f. **Hydrargyri Oxidum Rubrum.**—Red Oxide of Mercury. HgO.
Source.—Made by triturating together and heating

Mercury, and Mercuric Pernitrate obtained by dissolving Mercury in Nitric Acid. (1) $3Hg + 8HNO_3 = 3(Hg2NO_3) + 2NO + 4H_2O$. (2) $Hg2NO_3 + Hg = 2HgO + 2NO_2$.

Characters.—An orange-red powder, insoluble in water.

Impurities.—Red lead and brick-dust; detected by being non-volatile. Nitrate of mercury; by yielding nitrous vapours by heat.

Dose.—$\frac{1}{4}$ to 1 gr.

Preparation.

Unguentum Hydrargyri Oxidi Rubri.—"Red Precipitate Ointment." 1 in 8.

g. **Hydrargyri Iodidum Viride.**—Green Iodide of Mercury. HgI.

Source.—Made by rubbing together Mercury and Iodine in the presence of Rectified Spirit.

Characters.—A dull green powder, insoluble in water.

Impurity.—Biniodide of mercury, found by long keeping; detected by being soluble in ether.

Dose.—1 to 3 gr.

h. **Hydrargyri Sulphas.**—Sulphate of Mercury. $HgSO_4$.

Source.—Made by dissolving Mercury in hot Sulphuric Acid, and drying.

Characters.—A white, heavy, crystalline powder. Used only to prepare calomel and corrosive sublimate.

From Hydrargyri Sulphas are made:

a. **Hydrargyri Subchloridum.**—Subchloride of Mercury. Calomel. $HgCl$.

Source.—Made by subliming a mixture of Sulphate of Mercury, Mercury, and Chloride of Sodium; and washing with boiling water. (1) $HgSO_4 + Hg = Hg_2SO_4$. (2) $Hg_2SO_4 + 2NaCl = 2HgCl + Na_2SO_4$.

Characters.—A dull white, heavy, nearly tasteless powder, insoluble in water and spirit.

Incompatible with iodide of potassium, nitro-hydrochloric acid, hydrocyanic acid, solutions of lime, potash, and soda.

Impurities.—Perchloride of mercury; detected by being soluble in warm ether. Other chlorides; non-volatile.

Dose.—$\frac{1}{2}$ to 5 gr.

Preparations.

i. Lotio Hydrargyri Nigra.—Black Wash. Calomel, 30 gr.; Lime Water, 10 fl.oz.

ii. Pilula Hydrargyri Subchloridi Composita.—Plummer's Pill. Calomel, 1; Sulphurated Antimony, 1; Guaiacum Resin, 2; Castor Oil, 1. *Dose*, 5 to 10 gr.

iii. Unguentum Hydrargyri Subchloridi. 1 in 6½.

β. **Hydrargyri Perchloridum.**—Perchloride of Mercury. "Corrosive sublimate." $HgCl_2$.

Source.—Made by subliming a mixture of Sulphate of Mercury, Chloride of Sodium, and Black Oxide of Manganese. $HgSO_4 + 2NaCl = HgCl_2 + Na_2SO_4$. The manganese simply prevents the formation of calomel.

Characters.—Heavy colourless masses of prismatic crystals. Solubility, 1 in 20 of water.

Incompatible with alkalies and their carbonates, lime-water, tartar emetic, nitrate of silver, acetate of lead, albumen, iodide of potassium, soaps, decoction of bark.

Impurities.—Fixed salts; detected by not volatilising.

Dose.—$\frac{1}{16}$ to $\frac{1}{8}$ gr.

Preparations.

i. Liquor Hydrargyri Perchloridi.—½ gr. in 1 fl.oz. ($\frac{1}{16}$ gr. in 1 fl.dr.). *Dose*, 30 to 120 min.

ii. Lotio Hydrargyri Flava.—"Yellow Wash." Corrosive Sublimate, 18 gr.; Lime Water, 10 fl.oz.

From Hydrargyri Perchloridum are made:

iii. **Hydrargyri Iodidum Rubrum.**—Red Iodide of Mercury. HgI_2.

Source.—Made by mixing hot solutions of Perchloride of Mercury, and Iodide of Potassium, and purifying the precipitate. $HgCl_2 + 2KI = HgI_2 + 2KCl$.

Characters.—A vermilion crystalline powder. Soluble feebly in water, freely in ether.

Impurities.—As in the perchloride.

Dose.—$\frac{1}{16}$ to $\frac{1}{4}$ gr.

Preparation.

Unguentum Hydrargyri Iodidi Rubri.—1 in 28.

iv. **Hydrargyrum Ammoniatum.**—Ammoniated Mercury. "White Precipitate." NH_2HgCl.

Source.—Made by precipitating a solution of Perchloride of Mercury with Solution of Ammonia. $HgCl_2 + 2NH_4HO = NH_2HgCl + NH_4Cl + 2H_2O$.

Characters.—An opaque white powder, insoluble in water, spirit, and ether.

Impurities.—As in the perchloride.

Preparation.

Unguentum Hydrargyri Ammoniati.—1 in 8.

v. **Hydrargyri Oxidum Flavum.**—Yellow Oxide of Mercury. HgO.

Source.—Made by precipitating a solution of Perchloride of Mercury with a Solution of Soda.

Characters.—A yellow powder.

Impurities.—As in the perchloride.

i. **Liquor Hydrargyri Nitratis Acidus.**—Nitrate of Mercury, $Hg2NO_3$, in solution in nitric acid.

Source.—Made by dissolving Mercury in Nitric Acid and Water.

Characters.—A colourless, strongly-acid liquid.

Impurity.—Subnitrate of mercury; detected by giving precipitate when dropped into diluted hydrochloric acid.

j. **Unguentum Hydrargyri Nitratis.**—Citrine Ointment. Made by adding Lard melted in Olive Oil to a solution of Mercury in Nitric Acid.

Non-officinal Preparations of Mercury.

Oleate of Mercury.—Made by dissolving 5 to 20 per cent. of Yellow Oxide of Mercury in Oleic Acid.

Donovan's Solution.—Solution of Hydriodate of Mercury and Arsenic. *Dose*, 10 to 30 min.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Mercury in the form of the acid solution of the nitrate is a powerful **caustic,** employed to destroy growths on the skin, such as lupus, but must be used with caution. The perchloride applied in weak solutions is not absorbed, but acts destructively on organisms on or in the skin, such as those of ringworm. Stronger solutions cause inflammation of the skin, and concentrated solutions are caustic; but neither effect is surgically employed. A weak solution (gr. $\frac{1}{4}$ to the oz.) is used as a **disinfectant** and **stimulant** to ulcers, acting like other metallic salts (*see* pages 60 and 64), at the same time being absorbed, and producing the specific effects of the metal. Mercury itself, and most of the other preparations, cause little or no irritation of the skin, unless rubbed into it for some time.

The various *methods of administering mercury locally* must here be noticed.

(1) In the form of the ointment, metallic mercury may be applied by *inunction, i.e.* rubbed into a soft part of the skin. Thus applied, mercury undoubtedly enters the blood; but it has been contended that the metal is not admitted by the skin, but through the lungs, in the form of the vapour arising from the heated body smeared with the ointment, or even in small particles by the mouth. Fortunately, the question is of no practical importance, the fact remaining that the system can be quickly brought under the influence of mercury by inunction. The non-officinal oleate *painted* on the skin quickly conveys the metal into the system.

(2) The subchloride (calomel) may be administered by *fumigation.* The vapour of calomel, rising from a vessel heated by a lamp, is conducted to a part or to the whole of the surface of the body of the patient, and there allowed to settle as a fine deposit of the salt. The effect is increased by simultaneous diaphoresis, induced either by the vapour of water or by such a drug as jaborandi. 20 gr. of calomel may thus be fumigated, during a sitting of twenty minutes. The same doubt exists as to the precise way in which the calomel thus applied enters the blood.

(3) As a *bath* of dilute solutions of the perchloride, say 3 dr. to 30 gallons of water, with 1 dr. of hydrochloric acid.

(4) Mercurials may be dusted on to the raw surface of a blistered portion of the skin, or soft syphilitic growths (condylomata)—the *endermic* method, when it is rapidly absorbed.

(5) Solutions of the perchloride (albuminates or peptonates) may be injected *hypodermically*—a powerful method, but apt to produce sores.

(6) The vapour of mercurials may be *inhaled*, as we have seen; but this method is rarely employed intentionally.

(7) Mercury may be given *per rectum*, as the officinal suppositories.

The action of mercury admitted to a part of the body by any of these channels is usually more than local, the **specific** effects of the drug, presently to be described, being shortly developed. At the same time, the local effect will be more marked: skin diseases will be healed, condylomata removed, and indurations and chronic inflammatory processes reduced in connection with the bones or joints.

Internally.—The local action of mercury is the same as externally, according to the nature and strength of the preparation employed. Very dilute solutions of the perchloride (4 gr. to 10 fl.oz., with 8 min. of hydrochloric acid) may be used as a gargle or wash for syphilitic ulcers of the tongue and gums. All the salts of mercury act upon the mouth, gums, and salivary glands, causing salivation; but this effect is due to their excretion, not to their immediate influence on the parts, and will be described later.

In the stomach, mercurials combine with the chloride of sodium of the secretions, and, whatever their original form, are converted into a double chloride of sodium and mercury, which further unites with the albuminous juices, to form a complex molecule of mercury, sodium, chlorine, and albumen. This compound, although precipitated at first, is soluble in an excess either of chloride of sodium or of albumen; exists in the stomach, therefore, in solution; and is readily diffusible and easily absorbed. It is not specially irritant in moderate quantities, and none of the salts of mercury given in medicinal doses produce vomiting like zinc and copper; indeed, Dr. Ringer has shown that calomel in $\frac{1}{12}$-gr. doses, or Hydrargyrum cum Cretâ in $\frac{1}{3}$-gr. doses, given every two or three hours, arrests some forms of vomiting in children. In large or concentrated doses, however, mercurials are **irritant** or corrosive to the stomach, and must be given with caution, after meals.

The irritant effect of mercurials continues in the duodenum, naturally taking the form of purgation. The perchloride is never employed to produce this effect, but divided mercury in the form of the Pilula Hydrargyri and Hydrargyrum cum Cretâ, and Calomel, are common **purgatives**. The action of mercurials as purgatives is a purely local one, none of the metal being absorbed, but the whole expelled in the fæces. The exact nature of this action is, however, obscure. Probably the intestinal glands are chiefly stimulated to increased secretion, and the mucous membrane irritated to such a degree as to produce a moderate increase of watery exudation from its vessels into the bowel, peristalsis becoming more brisk at the same time. The result is a thorough evacuation of the contents of the small intestine as a large, loose, but not watery, stool, charged with bile, which has been hurried out directly from the duodenum, and not allowed to re-enter the portal circulation by absorption from the lower bowel, as it normally does. Thus mercurials, especially calomel, increase the amount of bile evacuated without increasing the amount secreted; that is, are **indirect cholagogues** by being duodenal purgatives. The manner in which indirect cholagogue action stimulates the liver to further secretion is discussed in Part III. The purgative action of mercurials is greatly assisted by a subsequent saline, such as Seidlitz powder, or the Mistura Sennæ Composita. The class of diseases in which mercurials are selected as purgatives chiefly include cases of congestion of the portal system and liver, especially those referable to secondary indigestion from free living or gout; cases of constipation attended by irritable stomach, or actual ulceration of the stomach or bowels; very rarely cases of habitual constipation, except at long intervals, to enable gentle laxative measures to act more freely; and occasionally diarrhœa, when it is distinctly referable to biliary derangement, or the presence of an irritant in the bowel, as in children.

2. ACTION ON THE BLOOD AND ITS USES.

As we have seen, mercury enters the blood freely through the broken or unbroken skin. From the bowel but a small part of a medicinal dose is absorbed, the rest passing off in the fæces as the sulphide, unless combined with opium, which delays its progress through the intestine. The complex molecule which mercury forms in the stomach and intestines is decomposed on entering the blood by combination with oxygen and albumen, an oxyalbuminate of mercury being the result, and apparently the same compound is formed when the metal enters by other channels.

No *direct* effect on the blood can be attributed to mercury; but impairment of nutrition generally, including digestion, attends its excessive use, and induces impoverishment, both of the plasma and the corpuscles, *indirectly* referable to the drug. The blood under these circumstances is more watery and coagulates less firmly, and nutrition may be further disordered in consequence, with the production of low forms of inflammation and ulceration. But it is to be clearly understood that this is not in any sense a specific effect of mercury, and that the influence of mercury upon inflammatory products and syphilitic growths, to be presently described, is not exerted through the blood, but upon the tissues themselves. The impoverishing effect of this drug upon the blood must be constantly kept in mind, and the quality of the blood sustained by abundance of food, and the strictest attention to digestion.

3. SPECIFIC ACTION.

Mercury quickly leaves the blood and enters the tissues, where it is apt to remain almost indefinitely, being excreted with comparative slowness, especially when the kidneys are diseased. It has been found in every organ of the body, most abundantly in the liver. It is a remarkable fact, however, that no definite anatomical change has ever been demonstrated in the viscera, such as the vessels, liver, or nervous system, even in cases of chronic poisoning by this metal; mercury in this respect again differing from lead, silver, antimony, and arsenic. Whilst, therefore, the specific action of mercury is unquestionable, its *mode* of action is still obscure, and numerous theories have been proposed to account for it, which need not be fully discussed here. The most probable explanation of the effects of mercury upon nutrition may be said to be that in some way or other it interferes with the growth or life of germinal cells, and that it has therefore an **alterative** influence on certain processes, such as inflammation and syphilis, which are characterised by a growth of small young cells. Possibly, it may have a destructive influence on certain ferments and organisms connected with physiological and pathological metabolism, one of these being the organism of syphilis.

Whatever may be the explanation of its action, mercury produces a train of symptoms, when given for a considerable period in moderate doses, known as "hydrargyrism," which chiefly take the form of debility; nervous phenomena, including muscular tremors and paralysis, pains, and mental disturbance; cardiac depression; ulceration of the skin, mouth and mucous membranes; salivation, dyspepsia, and diarrhœa. The temperature is not directly raised, nor the excretions increased, so that there is no positive evidence of increased metabolism as an effect of mercury.

4. SPECIFIC USES.

The uses of mercury as a specific remedy bear no definite relation to these effects, which have been mentioned chiefly that they may be recognised and arrested. The principal application of the drug is as an "alterative" in syphilis, a disease attended by the growth of cells around the small vessels, and the development of these into nodes, gummata, various eruptions, etc. Mercury has a powerful influence in controlling the severity of this disease. Its employment may be commenced with various local applications to the primary sore, and regular internal doses of the solution of the perchloride, calomel, grey powder, or some of the other preparations, until salivation threatens. It is generally (not universally) believed that the secondary stage is rendered less severe, or is even entirely prevented by this means. The drug must be continued during the appearance of secondary symptoms; but, as a rule, it is better omitted in the tertiary stage. The particular preparation employed varies with the experience of the practitioner. Quinine and opium are useful means of support to be combined with mercury in a course of the metal, and we must repeat that, unless the appetite and digestion continue good, its use must be interrupted.

The other use of mercurials as alterative remedies is in internal inflammations, especially inflammation of serous membranes, such as peritonitis, pericarditis, pleurisy, meningitis, and orchitis. This line of treatment, once universal in England, is now almost obsolete, excepting, perhaps, in peritonitis of a subacute or chronic kind, in which, as in most instances where it is used as an antiphlogistic, mercury is combined with opium. Possibly some of the benefit thus attending mercurialisation in inflammation, and which was formerly referred to a "resolvent" action on the fibrin of exudations, is due to its purgative and indirect cholagogue effects.

5. REMOTE LOCAL ACTION AND USES.

Mercury passes out of the system in all the secretions—the saliva, sweat, milk, urine, and bile, probably as an albuminate, and stimulates many of the glands *en route*. It is in this way, as we have seen, a powerful **sialagogue**, causing swelling of the salivary glands and a profuse flow of the secretions of the mouth. This effect is important only because it is to be avoided. The diaphoretic effect of mercury is comparatively insignificant. Whilst it does not increase of itself the volume of urine, it assists to a marked degree such **diuretics** as digitalis and scilla; but it must not be given in kidney disease, as it acts injuriously on the diseased tubules, and readily produces its debilitating effects when the renal function is impaired. In the fæces mercury leaves the body as the sulphide, being derived, first, from that considerable portion of the dose which is not absorbed; and, secondly, from the portion excreted by the liver (in the bile), and by the pancreas and intestinal glands. It will thus be seen that but little use is made of the remote local action of mercury.

6. ACTION AND USES OF THE DIFFERENT PREPARATIONS OF MERCURY.

The preparations of mercury, although so numerous, can be readily remembered, and their special actions understood, when they are classified as follows:

1. *Metallic Mercury* and preparations containing it.
2. The *Perchloride* of *Mercury* and its preparations.
3. The *Subchloride* of *Mercury* and its preparations.
4. The *Oxides*, *Iodides*, the *Ammoniated Mercury*, and their preparations, a complex group, the action and uses of which closely correspond either with those of the perchloride or with those of the subchloride.
5. *Acid Nitrate of Mercury* and the Ointment corresponding.

1. Metallic Mercury and its preparations.—These may be employed in all the classes of cases for which mercurials are adapted. The metal itself is never given internally, except in the finely-divided form in which it exists in Pilula Hydrargyri and Hydrargyrum cum Cretâ. The blue pill is chiefly used as a purgative and indirect cholagogue, but is also given in syphilis, in small doses combined with opium and quinine, and in combination with digitalis and scilla as a diuretic (the famous "Guy's pill)." Hydrargyrum cum Cretâ, or "grey powder," is a favourite purgative for children, and also a convenient preparation for a course of mercury in syphilis. Unguentum Hydrargyri, or "blue ointment," is the usual means of administering the metal by inunction in syphilis. A portion as large as a pea or hazel nut is rubbed daily into a soft part of the skin, such as the inside of the thigh, or smeared on flannel, and applied round the loins, the gums being carefully watched. This is a very sure and tolerably safe, but very dirty method, which is chiefly employed with infants. The non-officinal oleate, painted on, is a great improvement in this respect. Mercurial ointment may also be smeared over inflamed parts, such as the testis, and is used as a parasiticide. The Liniment of Mercury (the ointment in a liquid form) is chiefly employed as an antiphlogistic, being soaked on lint and applied to the affected part, *e.g.* the joints or the abdomen in subacute peritonitis. The same use may be made of the plasters, and of the compound ointment, "Scott's dressing." The suppository may be used in syphilis or to kill ascarides.

2. Perchloride of Mercury.—This is the most powerful of all mercurials. It is one of the most active of antiseptics, being 100 times as strong as carbolic acid, and may be used to disinfect foul ulcers, especially of syphilitic origin, a certain amount of caustic and stimulant effect being secured at the same time. It must be cautiously employed. It is also used to destroy the fungus of ringworm. Internally, as the Liquor (a weak solution), it is given in syphilis only, never as a purgative. In this form, the perchloride is by no means an irritant preparation of mercury, but rather the reverse. Lotio Hydrargyri Flava, "yellow wash," containing the yellow oxide, is applied to syphilitic sores.

3. Subchloride of Mercury.—Calomel resembles metallic mercury in being used externally and internally, as a purgative, alterative, and antisyphilitic remedy. Externally it is applied to syphilitic sores and chronic inflammatory growths as calomel dust, by fumigation, as the unguentum, and as the black wash. Internally calomel is a valuable purgative, with the powerful action as an indirect cholagogue and hepatic stimulant already described. The compound calomel pill (Plummer's pill) is in much repute as a hepatic stimulant and alterative, with little or no directly purgative effect, given every night or every other night for a week at a time, in gout and loaded conditions of the system consequent on free living. Calomel, combined with opium, was the favourite mercurial employed by the last generation of surgeons and physicians in the treatment of inflammation, to which we have already referred. In syphilis the same combination is still employed with success.

4. The Oxides, Iodides, and Ammonio-Chloride of Mercury.—These substances, although forming a convenient group, belong, as regard their action and uses, partly to the second and partly to the third group above. Thus the following closely resemble the perchloride, viz. Hydrargyri Oxidum Flavum, Hydrargyri Oxidum Rubrum, Hydrargyri Iodidum Rubrum, and Hydrargyrum Ammoniatum. The first two are almost exclusively used in syphilis, and externally, chiefly according to the opinion and custom of the practitioner. The "white precipitate" ointment is useful as a parasiticide, and as a stimulant application to chronic inflammatory eruptions of almost any kind in children. Along with the subchloride is to be classed Hydrargyri Iodidum Viride, which is much used in syphilis by some surgeons. Donovan's Solution is valuable in obstinate syphilides. The student will not forget that the Lotio Hydrargyri Flava really contains the yellow oxide, and the Lotio Hydrargyri Nigra, the black oxide, although they are reckoned as preparations of the perchloride and subchloride respectively.

5. Liquor Hydrargyri Nitratis Acidus, and the Ointment of the Nitrate.—These are not used in syphilis; but the former is used as a caustic in lupus and other limited growths and ulcers of the skin; while the ointment is of value as a stimulant in cases of chronic skin disease, and is applied to the edges of the eyelids in chronic inflammation and ulceration of the hair follicles.

Precautions in the use of mercurials.—Mercury must not be given as an alterative, antiphlogistic, or antisyphilitic remedy in persons with anæmia or debility, unless these are distinctly referable to syphilis, and even then it must be employed with caution. Tuberculosis and kidney disease also contra-indicate the use of mercury; and certain individuals will occasionally be met with in whom even small doses of calomel or blue pill quickly induce hydrargyrism by a kind of idiosyncrasy. In every instance the patient must be carefully nourished, as we have said. On the contrary, children—even infants—bear mercury very well, although the prolonged administration of the metal to them appears to produce a peculiar change in the permanent teeth when they appear, which is extremely unsightly ("mercurial teeth" of Hutchinson).

GROUP III.

THE METALLOIDS.

ARSENICUM. ARSENIC. AS. 75.

Acidum Arseniosum.—Arsenious Acid. White Arsenic. As_2O_3.

Source.—An anhydrous acid, obtained by roasting Arsenical Ores, and purified by sublimation.

Characters.—A heavy white powder, or stratified opaque masses. Solubility, 1 in 100 of cold water; 1 in 20 of boiling water. *Incompatibles:* Salts of iron; magnesia, lime-water, and astringent matters.

Impurities.—Lime salts; detected by non-volatility.

Dose.—$\frac{1}{60}$ to $\frac{1}{12}$ gr. in solution.

Preparations.

a. **Liquor Arsenicalis.**—"Fowler's Solution."

Source.—Made by dissolving Arsenious Acid and Carbonate of Potash in Water, and colouring with Compound Tincture of Lavender. 4 gr. in 1 fl.oz.

Characters.—A reddish liquid, alkaline to test-paper, with the odour of lavender.

Dose.—2 to 8 min.

b. **Liquor Arsenici Hydrochloricus.**—Hydrochloric Solution of Arsenic.

Source.—Made by boiling Arsenious Acid with Hydrochloric Acid and Water. No decomposition occurs. 4 gr. in 1 fl.oz.

Characters.—Colourless, with an acid reaction.

Dose.—2 to 8 min.

From Acidum Arseniosum is made :

c. **Sodæ Arsenias.** — Arseniate of Soda. $Na_2HAsO_4.7H_2O$.

Source.—Made by fusing Arsenious Acid with Nitrate and Carbonate of Soda, boiling the products in Water, and crystallising. (1) $As_2O_3 + 2Na_2NO_3 + Na_2CO_3 = Na_4As_2O_7 + N_2O_3 + CO_2$. (2) $Na_4As_2O_7 + 15H_2O = 2(Na_2HAsO_4.7H_2O)$.

Characters.—Colourless transparent prisms. Solubility, 1 in 2 of water. The solution is alkaline.

Dose.—$\frac{1}{16}$ to $\frac{1}{8}$ gr.

Preparation.

Liquor Sodæ Arseniatis.—4 gr. in 1 fl.oz.
Dose.—5 to 10 min.

From Arseniate of Soda is made :
Ferri Arsenias. See *Ferrum.*

Non-officinal Preparation of Arsenic :

Donovan's Solution. Solution of Hydriodate of Arsenic and Mercury. *Dose*, 10 to 30 min.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Arsenious acid is a powerful irritant and **caustic**. It is used occasionally to destroy lupus, epithelioma, and other superficial or limited new growths, in the form of "paste," composed of Arsenious Acid (1), Charcoal (1), Red Sulphuret of Mercury (4), and Water. In the form of a dilute ointment, it is employed in psoriasis to remove the scaly growth. Arsenic must be used locally with great care, as it is absorbed by the broken skin, ulcers, and mucous membranes, unless sufficient inflammation be set up to throw it off.

Internally.—The local corrosive action of arsenic may be employed in caries of the teeth to destroy the painful pulp before stopping, a paste composed of 2 parts of arsenious acid, 1 part of sulphate of morphia, and a sufficiency of creasote to make a stiff compound, being placed in the cavity.

Reaching the stomach in medicinal doses, the preparations of arsenic do not combine with the albuminous contents like mercury, but remain unchanged. They thus act upon the mucous membrane, stimulating the nerves and vessels, causing a sense of heat and hunger, and increasing the gastric function. In these small doses arsenic is employed with advantage in some cases of gastric dyspepsia, and a similar effect on the duodenum makes it of some value in lienteric diarrhœa. If the dose be increased, the stimulant action passes readily into **irritation of the stomach** attended by pain, sickness, and diarrhœa from intestinal excitement. These symptoms are to be remembered only that they may be avoided, or arrested if they should arise.

2. ACTION ON THE BLOOD AND ITS USES.

Arsenic enters the blood and **combines with the corpuscles,** not with the serum, as an albuminate; if in excess, it reduces the number of the blood cells, as well as their oxygenating power. It has been used with success in some forms of anæmia; but less frequently in idiopathic cases than where the corpuscles and plasma have suffered from failure of nutrition elsewhere (symptomatic anæmia), as in tuberculosis, malaria, gout, and rheumatism. Alone or combined with iron, it has sometimes an excellent effect in restoring the blood in such cases.

3. SPECIFIC ACTION AND USES.

Arsenic enters all the organs and tissues, but is not known to combine with their albuminous constituents; it remains in them for a short time only; and is quickly excreted. During this period, however, it distinctly influences metabolism. It first reaches the liver, and diminishes the amount of glycogen in it, so that it may be occasionally, but by no means often, used with success in diabetes. In the other organs it interferes similarly with metabolism, apparently (like phosphorus) through the oxygenating process. An increased amount of nitrogenous waste appears in the urine; the temperature rises; and the excessive fatty product of the albuminous decomposition remains unexcreted, constituting fatty degeneration. Short of this effect, arsenic produces a wholesome increase of the metabolism, or vital activity of all the organs, and is therefore given as a general **tonic**, and as a valuable **alterative** in such classes of disturbed nutrition as gout and chronic rheumatism. It is possible that arsenic affects the life processes of other living particles in the body besides the tissue elements, namely, the organisms of certain diseases. Thus it is, next to quinine, the most successful medicinal agent in the treatment of chronic malaria, brow-ague, and other varieties of neuralgia due to the same cause, and malarial cachexia; and is also used with advantage in hay-fever. It sometimes also dispels lymphomatous tumours. Beyond a safe amount, arsenic produces a series of nutritive disorders in the tissues, characterised chiefly by debility and nervous disturbances, known as "chronic arsenical poisoning," which need not be detailed here.

Next to nutrition generally, the nervous system appears to be most influenced by arsenic, which is found abundantly in the grey matter of the cord in poisoning by this metal. Here it acts by **diminishing** the **sensibility** and reflex irritability of the centres, as well as of the motor nerves and muscles. Preparations of arsenic are useful in chorea, various forms of neuralgia, and spasmodic asthma, especially when malaria or anæmia, or both, may happen to be associated with the neurosis. Like phosphorus, arsenic is said to cause increase of the compact tissue of bone at the expense of the medullary tissue, but it is not specially used to produce this effect. In large doses it has a depressing effect on the respiration, circulation, and temperature.

4. REMOTE LOCAL ACTION AND USES.

Arsenic is excreted chiefly in the urine in the form of arsenious acid; also by the liver and skin. It is not known to affect the kidney specially, but is sometimes used in chronic Bright's disease. The liver, as we have seen, is modified in its activity; and part of the value of arsenic in chronic gout, gravel, and skin diseases, may be referable to its action on the greatest metabolic organ in the body. Either thus indirectly, or directly, its effect on the skin is so remarkable, that it is the most valuable of all internal remedies for certain eruptions obviously connected with disordered nutrition, such as psoriasis, chronic eczema, acne, and pemphigus, whilst it aggravates such diseases as erythema multiforme. Donovan's Solution is used in syphilides.

5. METHODS OF ADMINISTERING ARSENIC, AND PRECAUTIONS IN ITS USE.

Arsenical preparations should always be given immediately at the end of meals, unless their gastric effect be desired, which is rarely the case; and they ought not to come in contact with the exposed mucous membrane. For the same reason they must not be given as alteratives if dyspepsia be present. Epigastric fulness, pain, and tenderness, a sense of constriction in the throat, irritation or soreness of the conjunctiva, and especially vomiting, ought to suggest a diminution or suspension of the drug. Children bear arsenic with comparative ease, whilst old subjects are said to bear it badly. A combination of iron with arsenic (for example, Vinum Ferri with Liquor Arsenicalis) is one of the best of hæmatinics and tonics, probably because the iron affords a supply of oxygen sufficient to carry to a complete termination the increased metabolism produced by the arsenic.

PHOSPHORUS. P. 31.

A non-metallic element obtained from bones.

Source.—Prepared from Phosphoric Acid or Superphosphate of Lime (obtained by acting on bone-ash by oil of vitriol), by distillation with Charcoal.

Characters.—A semi-transparent, almost colourless, wax-like solid, when fresh; luminous in the dark, ignites in the air; insoluble in water, soluble in ether, oils, and naphtha, entirely soluble in boiling oil of turpentine and bisulphide of carbon.

Preparations.

a. **Oleum Phosphoratum.** — Phosphorated Oil. Made by dissolving Phosphorus in Almond Oil at 180° Fahr. 1 in 160. *Dose*, 5 to 10 min.

b. **Pilula Phosphori.**—Phosphorus, Balsam of Tolu, and Yellow Wax. Apt to pass through the bowels unchanged. *Dose*, 3 to 6 gr. = $\frac{1}{30}$ to $\frac{1}{15}$ gr. of phosphorus.

Phosphorus is also used in preparing Acidum Phosphoricum Dilutum, and Calcis Hypophosphis. See *Calcium.*

ACTION AND USES.

Phosphorus has a powerful action on the body, and one which has been proved by elaborate investigations on animals to be of the most interesting kind to the physiologist. As a poison phosphorus is also of great importance. Unfortunately, however, it cannot be said to be of much value to the therapeutist, as it has disappointed most attempts to turn it to practical account in the treatment of disease.

1. IMMEDIATE LOCAL ACTION.

Externally and internally phosphorus acts as a powerful local **irritant** and **caustic**, and is never given to produce this effect. For the same reason the drug must not be ordered in the solid form, but carefully mixed with oil or fat.

2. ACTION ON THE BLOOD AND ITS USES.

Phosphorus enters the blood, and may be found in it unchanged. Here it is partly oxydised into phosphorus or phosphoric acid at the expense of the oxygen of the red corpuscles, and is therefore said to have a "**reducing**" **action on the (oxy-) hæmoglobin** or "blood." The small dose sufficient to cause death will not reduce any considerable number of the corpuscles, and the specific effects to be presently described cannot therefore be accounted for by interference with the oxygenating function of the blood.

Phosphorus has been employed in leukæmia and lymphadenoma, but on the whole with disappointing results.

3. SPECIFIC ACTION AND USES.

In the tissues phosphorus may be traced as the uncombined element—another proof that its oxydation in the blood is incomplete. Its effect on metabolism, when given in large doses, is most distinct and definite: it increases the nitrogenous products, including urea, tyrosin, and leucin; reduces the glycogen of the liver to *nil;* raises the temperature, diminishes the excretion of carbonic acid, and the volume of oxygen absorbed; and leads to fatty degeneration of epithelial, glandular, and muscular protoplasm throughout the body. No doubt these **alterative** effects are essentially associated with each other; phosphorus, whilst increasing metabolism, so influencing it as to diminish oxydation, and thus to arrest the process at the first stage, where proteids are converted into urea and oil, instead of allowing it to proceed to the second or final stage, where the oil is further oxydised into carbonic acid and water. Hence all the results just enumerated; whilst the soluble products (urea, etc.) are excreted, the insoluble products (oils or fats) are retained in the tissues, constituting fatty degeneration.

The uses to which phosphorus has been put as a specific remedy do not obviously depend upon these effects upon nutrition. It has been given in nervous disorders, such as neuralgia; in adynamic conditions, such as typhoid fever; in some kinds of skin diseases, including pemphigus; and as an aphrodisiac. It is difficult to understand how any of these morbid states can be benefited by a substance which diminishes oxydation; and, indeed, the empirical use of phosphorus has recently been in a great measure abandoned.

In very small doses over a considerable length of time, phosphorus affects the structure of bones, converting the spongy portion into firm, compact substance, without in any way altering its composition chemically. It has therefore been recommended in cases of rickets and ununited fracture; but in rickets, at least, is far inferior to other medicinal measures, if of service in any way.

The *hypophosphites* have recently been much employed in cases of nervous and general debility and chronic lung disease, and act, according to some authorities, in the same manner as free phosphorus, without being irritant. As the hypophosphites are probably converted into phosphates in the stomach, they may be expected to stimulate the liver and bowels, and to affect the growth and healing of bones, lymphatic glands, and adenoid tissue, including tubercle.

4. REMOTE LOCAL ACTION.

Phosphorus is excreted by the kidneys as phosphorus and phosphorous acid, not as phosphates; but is not employed in this connection.

ANTIMONIUM. Sb. 122. ANTIMONY.

The metal itself (Stibium) is not officinal, all the preparations being derived from "black antimony," Antimonium Nigrum, as follows:

Antimonium Nigrum.—Black Antimony. Native Sulphide of Antimony. Sb_2S_3.

Source.—Purified from siliceous matter by fusion, and powdered.

Characters.—A metallic-looking powder, of a steel-grey colour.

Impurity.—Silica; insoluble in boiling HCl.

Not given medicinally.

From Antimonium Nigrum are made:

a. **Antimonium Sulphuratum.**—Sulphurated Antimony. Sulphide of Antimony, Sb_2S_3, with a small and variable amount of Oxide of Antimony, Sb_2O_3.

Source.—Made by (1) boiling Black Antimony with Solution of Soda, and (2) precipitating with Diluted Sulphuric Acid. (1) $2Sb_2S_3 + 6NaHO = 2Na_3SbS_3 + Sb_2O_3$

$+ 3H_2O$. (2) $2Na_3SbS_3 + 3H_2SO_4 = Sb_2S_3 + 3Na_2SO_4 + 3H_2S$.

Characters.—An orange-red powder, without odour, and with a slight taste, insoluble in water.

Impurities.—General; detected volumetrically.

Dose.—1 to 5 gr.

Antimonium Sulphuratum is an important ingredient of Pilula Hydrargyri Subchloridi Composita. 1 in 5. (See *Mercury.*)

b. **Liquor Antimonii Chloridi.**—Solution of Chloride of Antimony, $SbCl_3$, in Hydrochloric Acid. "Butter of Antimony."

Source.—Made by dissolving Black Antimony in Hydrochloric Acid. $Sb_2S_3 + 6HCl = 2SbCl_3 + 3H_2S$.

Characters.—A heavy yellowish-red liquid, giving a white precipitate with water.

From Liquor Antimonii Chloridi is made:

Antimonii Oxidum.—Oxide of Antimony. Sb_2O_3.

Source.—Made by (1) precipitating Oxychloride of Antimony, by pouring the Solution of the Chloride into Water; washing; and (2) adding Carbonate of Soda Solution. (1) $12SbCl_3 + 15H_2O = 2SbCl_3 5Sb_2O_3 + 30HCl$. (2) $2SbCl_3 5Sb_2O_3 + 3Na_2CO_3 = 6Sb_2O_3 + 6NaCl + 3CO_2$.

Characters.—A greyish-white powder, insoluble in water.

Impurities.—Higher oxides, insoluble when boiled with acid tartrate of potash.

Dose.—1 to 4 gr.

Preparation.

Pulvis Antimonialis—"James's Powder." 1, with 2 of Phosphate of Lime. *Dose,* 3 to 10 gr.

From Antimonii Oxidum is made:

Antimonium Tartaratum.—Tartarated Antimony. Tartar Emetic. $KSbC_4H_4O_7.H_2O$.

Source.—Made by boiling Oxide of Antimony with Acid Tartrate of Potash, and crystallising. $2KHC_4H_4O_6 + Sb_2O_3 = 2KSbC_4H_4O_7 + H_2O$.

Characters.—Colourless transparent crystals, exhibiting triangular facets. Solubility, 1 in 20 of cold water; 1 in 2 of boiling water.

Incompatibles.—Gallic and tannic acids, most astringent infusions, alkalies, lead salts.

Impurities.—Cream of tartar, and iron; detected volumetrically, and by solubility.

Dose.—As a diaphoretic, $\frac{1}{16}$ to $\frac{1}{6}$ gr.; as an emetic, 1 to 2 gr.

Preparations.

(1) Unguentum Antimonii Tartarati.—1 to 4.

(2) Vinum Antimoniale.—2 gr. in 1 fl.oz. *Dose,* 5 min. to 1 fl.dr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Antimony, in the form of the Liquor Antimonii Chloridi, is a **escharotic**, employed chiefly in veterinary practice, occasionally by the surgeon as an application to poisoned, foul, or malignant surfaces. Tartarated Antimony applied to the skin, either in aqueous solution or as the officinal ointment (half a drachm at a time, repeated), causes a pustular eruption, and was once used as a **counter-irritant** in diseases of the lungs, joints, or meninges. Antimony is freely absorbed from the broken skin, and from mucous surfaces.

Internally, the local effect is equally irritant. In doses of 1 to 3 grains tartarated antimony is an **emetic**, whence its popular name. The effect is partly direct—due, that is, to the irritant action of the drug upon the walls of the stomach; partly indirect, from immediate stimulation of the vomiting centre in the medulla. Further, its direct effect on the stomach is produced not only when the salt is admitted to it by the mouth, but when it reaches the stomach by the blood, that is, when it is being excreted by the gastric mucosa. Thus, whilst tartar emetic induces vomiting most quickly when swallowed, it is not speedy and evanescent in its effects, but induces both previous and subsequent nausea and depression. It is not suited, therefore, for use in cases of poisoning, where rapid evacuation is of the first importance, or where there is much general depression; but is useful in the first stage of acute inflammatory diseases, with sthenic fever, in strong healthy subjects. It is especially indicated in respiratory affections, such as laryngitis and bronchitis, where its remote effects as an expectorant are valuable; or to clear the air-passages in the same diseases or in whooping cough.

In smaller continued doses the local action of tartarated antimony on the stomach and bowels is apt to produce loss of appetite, nausea, pain, and diarrhœa.

2. ACTION IN THE BLOOD.

Antimony enters the blood either from within or from without, but does not appear to combine with the albumen of the plasma. No special action or use has to be mentioned under this head.

3. SPECIFIC ACTION AND USES.

Having reached the tissues and organs, antimony clings to them with some tenacity, and may be found in them months after its administration. Here it sets up a series of important changes, attended by phenomena referable to the general nutrition of the body, the circulation, respiration, and nervous and muscular systems; besides the effects to be afterwards described as referable to its excretion.

The effect of antimony on *metabolism* closely resembles that of phosphorus and arsenic, to the account of which the student is referred. Briefly the principal results are fatty degeneration of the organs and increase of the nitrogenous products, oxygenation being comparatively deficient. Upon this **alterative** effect depends in part the value of antimony in gout, chronic skin disease, etc., to be afterwards described. The *heart* is depressed from the first by tartarated antimony. Even in small doses it reduces the strength, and very soon the frequency of the pulse, which tends to become irregular, and fainting may occur; the whole being referable to a direct action upon the nervo-muscular substance of the heart. Antimony is thus a powerful **circulatory depressant.** The *respiratory* movements are also weakened and disturbed by this drug, which causes shortness of inspiration and lengthening of expiration, manifestly a degree of the same disturbance which culminates in vomiting, and allied to the process of expectoration. The *nervous system* is markedly depressed by antimony, in part directly, in part indirectly through the circulation, the effect of a moderate dose being to produce a sense of languor, inaptitude for mental exertion, lowness, and sleepiness. Tartarated antimony has accordingly been used as a **sedative** in the delirium and insomnia of fevers, such as typhus, and acute alcoholism (delirium tremens), combined with opium in various proportions.

The *muscular system* is so powerfully depressed by antimony that, before the introduction of chloroform, it was employed to produce muscular relaxation in the reduction of herniæ and dislocations. Nauseating and emetic doses cause great weakness of the voluntary movements, inability to stand, occasional tremors, and aching of the muscles. It is still given as an **antispasmodic**, to relax the cervix uteri in some classes of difficult labour, and in combination with purgative medicines to prevent or remove spasm of the bowel.

4. REMOTE LOCAL ACTION AND USES.

Antimony leaves the system by all the mucous surfaces, the liver, kidneys, and skin; so that it may cause inflammation, salivation, and pustulation of the mouth, œsophagus, and stomach when administered by the skin. In being excreted by the *stomach*, it produces there, as we have seen, a remote emetic effect. Its excretion in the *bile* constitutes it a hepatic stimulant, sulphurated antimony, either as Plummer's pill or alone, being much esteemed as a **cholagogue**, especially in gout and loaded conditions of the liver. In passing through the *kidneys*, it has a slight diuretic action. In doses of $\frac{1}{10}$ to $\frac{1}{5}$ gr., it stimulates the skin, acting as a diaphoretic, of service, as we shall see, in feverish conditions. Its internal use occasionally develops the characteristic pustular eruption, which suggests it as a remedy for certain forms of chronic skin disease. Antimonial wine is a familiar **sedative expectorant**, apparently from the excretion of the drug by the respiratory surfaces, given with great advantage in the first stage of acute bronchitis in strong subjects, less frequently in acute pneumonia.

5. USES OF THE COMBINED ACTIONS OF ANTIMONY.

When the various effects of antimony thus detailed are reviewed together, it is found to be a powerful general depressant, oxygenation being impaired, nervo-muscular activity reduced, the heart weakened, and the waste of the body increased through all the channels of excretion, and by loss of heat. When a full dose (1 to 3 gr.) is given, and vomiting induced, this general depression may threaten to pass into collapse, with pallor and coldness of the surface, and marked fall of the body temperature. On this account tartarated antimony may sometimes be employed with benefit as an **antipyretic** or febrifuge at the commencement of acute febrile attacks in sound robust subjects, more especially bronchitis, where the attendant increase of the bronchial secretion will be serviceable, and the possible emesis by no means contra-indicated. Great caution must, however, be exercised in prescribing this powerful depressant, and the best method of administering it is in very small doses in water every fifteen or thirty minutes, until the skin becomes moist and cool, when it may be stopped.

The unquestionable value of Plummer's Pill would appear to be partly referable in the same way to the action of antimony not only on nutrition, but on the various organs of elimination, including the skin and the kidneys.

BISMUTHUM. BISMUTH. Bi. 210.

A crystalline metal; as met with in commerce it is generally impure.

From Bismuthum is made:

Bismuthum Purificatum.—Purified Bismuth.

Source.—Made by heating Bismuth with Nitrate of Potash.

Characters.—A crystalline metal of a greyish-white colour, with a roseate tinge.

Impurity.—Copper; giving coloured reactions.

From Bismuthum Purificatum are made:

a. **Bismuthi Subnitras.**—Subnitrate of Bismuth. White Bismuth. $BiONO_3H_2O$.

Source.—Made (1) by dissolving Purified Bismuth in Nitric Acid; and (2) pouring the product into Water. (1) $Bi_2 + 8HNO_3 = 2(Bi3NO_3) + 2NO + 4H_2O$. (2) $Bi3NO_3 + H_2O = BiONO_3 + 2HNO_3$.

Characters.—A heavy white powder, in minute crystalline scales; insoluble in water.

Impurities.—Carbonate of lead; giving precipitate with H_2SO_4 when dissolved in HNO_3; arsenic; and chlorides.

Dose.—5 to 20 gr.

Preparation.

i. Trochisci Bismuthi.—2 gr. Subnitrate of Bismuth in each, Carbonate of Lime, and the usual ingredients of a lozenge. *Dose*, 1 to 6.

From Bismuthi Subnitras is made:

ii. **Bismuthi Oxidum.**—Oxide of Bismuth. Bi_2O_3.

Source.—Made by boiling Subnitrate of Bismuth in Solution of Soda.

Characters.—A dull lemon-yellow powder; insoluble in water, soluble in nitric acid mixed with half its volume of water.

Impurities.—As of the subnitrate.
Dose.—5 to 15 gr.

β. Liquor Bismuthi et Ammoniæ Citratis.
Source.—Made by dissolving Purified Bismuth in Diluted Nitric Acid, adding Citric Acid, and redissolving the precipitate with Ammonia, as it forms.

Characters.—A colourless solution, with a saline and slightly metallic taste; neutral or slightly alkaline to test-paper; mixes with water without change. 1 fl.dr. contains 3 gr. of oxide of bismuth.

Dose.—½ to 1 fl.dr.

γ. Bismuthi Carbonas.—Carbonate of Bismuth. $2(Bi_2CO_5)H_2O$; an oxycarbonate.

Source.—Made by (1) dissolving Purified Bismuth in Nitric Acid and Water; and (2) precipitating by a solution of Carbonate of Ammonia. (1) $Bi_2 + 8HNO_3 = 2(Bi3NO_3) + 2NO + 4H_2O$. (2) $4(Bi3NO_3) + 3(N_4H_{16}C_3O_8) = 2Bi_2CO_5 + 7CO_2 + 12NH_4NO_3$.

Characters.—A white powder, insoluble in water; soluble with effervescence in nitric acid.

Impurities.—The subnitrate, and its impurities.

Dose.—5 to 20 gr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally applied in the form of powder or ointment, bismuth acts only physically on the unbroken skin, protecting it from the irritation of cold and dirt. If the surface be inflamed, as in chapped hands, chapped nipples, irritable ulcers, and eczema, it is a mild **sedative** and **astringent**, soothing and drying up the part. Accessible mucous membranes are similarly affected by bismuth, when in a condition of catarrh: thus it is used with success as a "snuff" for nasal catarrh; as an injection in gonorrhœa and leucorrhœa; and in irritability of the cervix uteri as a pessary. Bismuth is not known to be absorbed from the surface.

Internally, the local action and uses of the subnitrate of bismuth constitute all, or nearly all, that is definitely known respecting it as a remedy. In the stomach it is insoluble, and exerts the same **sedative** and **astringent** action as on the skin, whether by affecting the nerves and local circulation, or by its mechanical properties, that is, by coating and protecting the mucous surface. Little or no good is to be expected from less than 20 gr. doses of the subnitrate to an adult, and these may be trebled with perfect safety. Bismuth is extensively used in this country in the treatment of pain and vomiting due to catarrh or organic disease of the stomach, such as the gastric catarrh that follows a surfeit of food or alcoholic excess, recurrent gastric ulcer, and cancer; also in some cases of so-called nervous or reflex vomiting, as in pregnancy and hysteria, where a true catarrh is often present. Bismuth may be given alone in such conditions, but is better combined, on the one hand, with alkalies, such as bicarbonate of soda, if there be much actual catarrh; or, on the other hand, with opium, if pain be the chief symptom. A combination of the subnitrate of bismuth and a variable number of grains of Pulvis Ipecacuanhæ Compositus is almost a specific for the pain and vomiting of ulcer and malignant disease.

The astringent and sedative influence of bismuth on the intestines constitutes it a valuable remedy for diarrhœa in delicate persons, such as children, phthisical subjects, and those who have been exhausted by other causes. In lienteric diarrhœa, probably referable to duodenal catarrh, it is sometimes invaluable. But in the intestines, as in the stomach, the addition of opium, in however small quantity almost, greatly assists its action, and in persistent cases of diarrhœa is absolutely necessary. The same combination with Dover's powder gives excellent results. Bismuth subnitrate is partly converted into the sulphide in the bowel, which imparts a characteristic leaden-grey colour to the fæces.

2. ACTION IN THE BLOOD.

Neither the insoluble nor the soluble (but weak) preparations of bismuth enter the blood in any quantity. Still, the metal has been detected, both here and in the tissues.

3. SPECIFIC ACTION.

Bismuth finds its way, but very slowly, through all the organs and tissues; but no specific effect can be traced to its presence, even when it is given in doses of several drachms. The so-called effects of bismuth, of the older authorities, were certainly caused by arsenic combined with it as an impurity.

4. REMOTE LOCAL ACTION.

Bismuth has been found in the urine, and it is said, in the milk. No use is made of its remote influence, if any such exist.

CHLORUM. CHLORINE. Cl. 35·5.

Although not contained in the Pharmacopœia as the pure gas under its own name, chlorine is furnished by several important preparations, as follows :

a. **Liquor Chlori.**—Solution of Chlorine. Chlorine gas dissolved in Water.

Source.—Made by heating Hydrochloric Acid in water with Black Oxide of Manganese, passing the gas into Water, and shaking till it is absorbed.

Characters.—A yellowish - green liquid smelling strongly of chlorine.

Impurities.—Salts, not volatile ; deficient Cl, detected volumetrically by hyposulphite of soda.

Incompatibles.—Salts of lead and silver.

Dose.—10 to 20 min. in water.

b. **Calx Chlorata.**—*See* page 50.

α. Liquor Calcis Chloratæ.—*See* page 50.

β. Vapor Chlori.—Chlorinated Lime and Water. —*See* page 50.

c. **Liquor Sodæ Chloratæ.**—*See* page 38.

α. Cataplasma Sodæ Chloratæ.—*See* page 38.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, the action and uses of chlorine depend upon the great affinity which it possesses for hydrogen, and its consequent power to decompose compounds in which hydrogen forms part of the molecule, such as ammonia, sulphuretted hydrogen, sulphide of ammonium, and water. The properties of the body on which it acts (chemical, vital, or both) are completely altered; whilst nascent oxygen is set free, and chlorine further combines with the remaining elements of the broken-down molecule. Thus it is a powerful **irritant** to the skin, causing redness, vesication, even sloughing, and coagulating the albuminates of the part. For the same reason chlorine is the most powerful of all **disinfectants, deodorisers, and decolorisers,** its activity as a disinfectant greatly exceeding that of carbolic acid, and even corrosive sublimate. As a stimulant and disinfectant, chlorine water, or the solutions of chlorinated lime or of chlorinated soda, may be applied to foul ulcers, dissection and poisoned wounds, diphtheritic surfaces; or used in contagious ophthalmia, ozœna, and other foul discharges from surfaces or cavities. Of much more extensive application is the disinfectant action of chlorinated lime and its preparations, apart from the body: to purify rooms, wash infected clothes, flush drains, and throw upon the stools of typhoid fever and cholera before they are disposed of.

Internally, chlorine exerts the same local action upon the parts with which it comes in contact; and is employed as a wash or gargle, to disinfect and stimulate foul ulcers of the mouth, tongue, and throat, especially in diphtheria.

In the stomach chlorine in dilute solutions becomes converted into hydrochloric acid and chlorides, and loses all further effect upon the body as the uncombined element.

Inhaled as the vapour, chlorine causes local irritation of the respiratory passages, with distressing pain in the throat and chest, spasm, cough, lachrymation, sneezing, and headache. It cannot be recommended in this form or for this purpose.

2. ACTION IN THE BLOOD, SPECIFIC ACTION, AND REMOTE LOCAL ACTION.

It is doubtful whether chlorine enters the circulation or reaches the tissues, uncombined; more probably it is entirely converted into chlorides. From the analogy of its powerfully disinfectant and bleaching properties apart from the body, it has been given, as an "alterative and stimulant," in typhus, typhoid fever, small-pox, and other "putrescent" diseases, as well as in chronic dysentery, and liver disease of a malarial origin. There is little evidence in favour of continuing its use in these cases.

IODUM. Iodine. I. 127.

Under this head will be discussed both Iodine and Iodide of Potassium, the form in which the element is generally administered internally. Reference will also be made to the other officinal iodides.

Iodum.—Iodine. I.

Source.—A non-metallic element, obtained principally from Kelp, the ashes of sea-weed.

Characters.—Laminar crystals of a dark colour and lustre, and peculiar odour. Solubility, 1 in 7,000 of water, 1 in 12 of rectified spirit, 1 in 4 of ether, sparingly in glycerine, freely in a solution of iodide of potassium or chloride of sodium. Seldom given as pure iodine.

Impurities.—Iodide of cyanogen; subliming as colourless pungent prisms. Iron; not volatile. Water; as moisture. Deficient iodine; detected by hyposulphite of soda.

Incompatibles.—Ammonia, metallic salts, mineral acids, vegetable alkaloids.

Preparations.

a. **Linimentum Iodi.**—Iodine, 5; Iodide of Potassium, 2; Camphor, 1; Spirit, 40.

b. **Liquor Iodi.**—Iodine, 20 gr.; Iodide of Potassium, 30 gr.; Water, 1 oz.

c. **Tinctura Iodi.**—Iodine, ½; Iodide of Potassium, ¼; Spirit, 20. *Dose,* 5 to 20 min.

From Tinctura Iodi is prepared:

Vapor Iodi.—Tincture of Iodine, 1 fl.dr.; Water, 1 fl.oz.

d. **Unguentum Iodi.**—Iodine, 32 gr.; Iodide of Potassium, 32 gr.; Spirit, 1 fl.dr.; Lard, 2 oz.

From Iodum is made:

Potassii Iodidum. — See *Potassium,* for *source* and *characters.* *Dose,* 2 to 10 gr. or more.

Preparations.

α. Linimentum Potassii Iodidi cum Sapone.—Iodide of Potassium, 1½; Hard Soap, 1½; Glycerine, 1; Oil of Lemon, ⅛; Water, 10.

β. Unguentum Potassii Iodidi.—Iodide of Potassium, 64 gr.; Carbonate of Potash, 4 gr.; Water, 1 fl.dr.; Lard, 1 oz.

γ. Also all preparations of Iodum.

Iodine is also used in the production of the Iodides of Cadmium, Ferrum, Hydrargyrum (2), Plumbum, and Sulphur.

Solutions of Iodine may be decolorised by Hyposulphite of Soda.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally applied, iodine is a powerful **irritant** and **vesicant,** decomposing organic molecules, and entering into loose chemical combination with the albuminous constituents of the parts. At the same time it stains the epidermis of a deep brown, causes considerable pain; and is absorbed into the blood, partly by the skin and partly by the air of respiration in the form of vapour. It is also a powerful **antiseptic** and **disinfectant**.

The tincture, liniment, and ointment of iodine are extensively used as stimulants and disinfectants to foul, callous ulcers, much like nitrate of silver; as vegetable parasiticides in ringworm; and as counter-irritants in subacute or chronic inflammation of joints, periosteum, lymphatic glands, the pleura, and the lungs. In these instances the chief effect is doubtless stimulation, but a certain amount of the iodine is absorbed, and acts specifically, as will be presently described. Iodine in solution is injected into cysts, goîtres, hydrocele, etc., with much success.

Iodide of potassium applied to the unbroken skin is neither irritant nor capable of being absorbed, unless decomposed by the sweat. It is readily taken up from the exposed mucous membranes. How much specific value can be attached to the iodide liniment is doubtful.

Internally, the local action of free iodine is also irritant, and it is successfully applied to the gums in periosteal toothache. Inhaled into the respiratory passages, it gives rise to cough, sneezing, severe pain over the frontal sinuses, distressing pains in the chest, and dyspnœa. Combinations of iodine with creasote and various soothing volatile substances, such as chloroform and ether, have lately come into repute as continuous inhalations in the so-called "antiseptic" treatment of phthisis, bronchitis, and other forms of chronic lung disease.

In the stomach and bowels, although it is gradually converted into the iodide or iodate of sodium, the irritant effects of free iodine are continued, with abdominal pain, sickness, and diarrhœa as the result. The iodides of potassium and sodium have rarely this effect, and it is only in the form of a salt that iodine is now administered internally. Iodide of potassium is also decomposed in the stomach, the sodium salt and albuminate being formed from it.

2. ACTION ON THE BLOOD.

Iodine is freely absorbed into the blood from mucous surfaces, and the sodium iodide quickly enters from the alimentary canal. In the blood the element is at first combined with sodium; but this salt appears to be decomposed, the iodine for a time set free, some of the red corpuscles broken down (if the amount of iodine be large), and bloody effusions and bloody urine make their appearance. Such results are to be carefully avoided in practice; and, as far as we know, less degrees of the same cannot be usefully applied to therapeutical purposes, unless the tendency to coagulation of the blood be somewhat increased by it.

3. SPECIFIC ACTION AND USES.

The iodide of sodium and albuminous compounds pass from the blood into the tissues with remarkable rapidity, and may be found in all of them, especially the excreting organs and lymphatic glands, whilst they appear very scantily in the nervous centres. Almost as quickly the iodine leaves the tissues; and in thus passing rapidly through the protoplasm of the body, and sharing in its metabolism by combining (probably very loosely) with the albuminous molecules, it no doubt **accelerates tissue change.** As no increase of urea accompanies this effect, nor bodily wasting, the iodine must either spare the liver (which is the chief source of urea), or accelerate the metabolism of the plasma, rather than of the tissue elements themselves. (See *Metabolism*, Part III.) However this may be, the following are the principal directions in which iodine affects nutrition, and their applications:

(1) The *lymphatic glands* are reduced in size by iodine, which is extensively used for **scrofulous** and other chronic enlargements of the glands, whether applied locally as iodine, or internally as the iodides.

(2) Certain *poisons*, which have intimately associated themselves with the albuminous structures, are disengaged from this combination by iodine. Lead and mercury may be swept out of the tissues by iodide of potassium administered for plumbism and hydrargyrism respectively. The principal application, however, of iodine is in the treatment of **syphilis.** Either the poison of this disease is thus eliminated from the system, or iodine hastens the life and disappearance of the small-celled growth by which syphilis is characterised. It is specially valuable in the tertiary forms of syphilis, when mercury cannot be longer given with advantage; and nodes and other superficial enlargements, gummata in the viscera, and certain forms of skin disease may be very successfully treated by the potassium salt. The same precautions must be observed with respect to the general health, and especially the preservation of digestion in a course of iodide, as were laid down under the head of mercury.

(3) In subacute and **chronic inflammations** of various kinds, such as exudations or effusions in connection with the joints and serous cavities, and some forms of pulmonary consolidation, iodide of potassium may promote absorption by stimulating the

local nutrition. The local application of iodine "paint" is combined in such cases.

(4) *Scrofula* is benefited by iodine, especially when it affects the lymphatic glands, enlargements of which are treated by the liniment, by the ointments of the iodides of lead or cadmium, or by interstitial injections (rarely); internally by iodide of iron, or iodine mineral waters, such as the water of Woodhall. On the contrary, phthisis is rarely benefited by iodides, unless there be a syphilitic taint present.

(5) In chronic *rheumatism*, when debility is not a prominent symptom, in gonorrhœal rheumatism, and in the arthritis of syphilis, the iodide may be beneficial. In chronic arthritic gout it is probably useless, or even prejudicial.

The nervous system, respiratory centre, heart and vessels, and the body temperature are all unaffected by iodine; and the depressing effect on these of large doses of iodide of potassium is believed to be caused by the potassium. The remarkably useful effect of potassium in relieving or curing **aneurism** is due to the reduction of the blood pressure by the alkali, the coagulating effect of iodine on the blood, and the specific effect of iodine on the chronic inflammatory changes (often syphilitic) in the wall of the artery which have led to the dilatation.

4. REMOTE LOCAL ACTION AND USES.

Iodine is rapidly excreted, appearing in the urine, the mucous secretions generally, and specially in those of the air-passages, the perspiration, saliva, bile, and milk. Part of the sodium salt which reaches the excreting organs is thrown out unchanged, part is decomposed, and iodine is again set free to exert its local action remotely.

The diuretic effect of iodide of potassium is not marked unless large doses be given, and probably depends upon the alkali, not on the iodine. The latter may, however, have an alterative action upon the kidney, and the iodide may therefore be used in some forms of chronic Bright's disease, combined with other remedies.

The excretion of iodine by the mucous membrane of the respiratory tract is of most interest to the therapeutist. In certain subjects, and probably when iodide of potassium contains free iodine as an impurity, its exhibition produces a series of distressing symptoms known as "iodism," consisting of coryza, the watery discharge from the nose being sometimes profuse; sneezing; intense pain of a bursting character over the frontal sinuses, commonly called "headache;" swelling and redness of the gums, hard and soft palate and fauces, foulness of the tongue, and increase of the mucus of the mouth; cough and frothy expectoration, and a sense of heat and rawness in the trachea and chest. The phenomena of irritation of the respiratory mucosa by the out-going iodine are therefore identical with those produced by the immediate action of iodine by inhalation, but in a minor degree. When the secretion is deficient, the mucous membrane of the bronchi swollen and dry, and cough useless and painful, iodide of potassium is thus a valuable **expectorant**, quickly inducing a flow of thin mucus, by establishing secretion, or by liquefying tenacious mucus which may be plugging or irritating the bronchi. It is, further, an indirect **antispasmodic**, given with great benefit in asthma and emphysema. The iodide of ethyl (non-officinal) inhaled as vapour may rapidly relieve the spasm of asthma. Iodide of potassium is sometimes given in other respiratory diseases, *e.g.* in pneumonia, if the consolidation threaten to persist.

In escaping by the skin the liberated iodine produces in certain individuals peculiar **eruptions**, generally papular or slightly vesicular, rarely purpuric. The value of the drug in tertiary syphilitic diseases of the skin no doubt depends partly on this influence.

5. ACTION AND USES OF THE SEVERAL PREPARATIONS CONTAINING IODINE.

1. *Cadmii Iodidum:* Unguentum Cadmii Iodidi. — The ointment only is employed, and combines the stimulant effects of the two elements. It is rubbed into the skin over enlarged glands, stiff joints, etc. See *Cadmium.*

2. *Ferri Iodidum:* Pilula Ferri Iodidi and Syrupus Ferri Iodidi combine the action of the two important elements, and are especially indicated and extensively employed when iodine has to be administered for a length of time to anæmic subjects. This is the form in which iodine is usually given in scrofula, the syrup being a favourite remedy for strumous children.

3. *Hydrargyri Iodidum Rubrum* possesses chiefly the action of the per-salts of mercury, and is used accordingly. See *Hydrargyrum.*

4. *Hydrargyri Iodidum Viride* is also a mercurial rather than an iodide in its action, and is employed in syphilis much like calomel.

5. *Sulphuris Iodidum* is now used externally only, and is believed to produce the combined effects of the two alteratives.

BROMUM. Br. 80. BROMINE.

A liquid non-metallic element.

Source.—Obtained from Bitter, and from some Saline Springs.

Characters.— A dark brownish-red very volatile liquid, with a strong disagreeable odour; solubility, 1 in 30 of water.

Impurity.—Iodine; detected by starch test.

Not given internally.

From Bromum are made:

1. **Ammonii Bromidum.**—See *Ammonium. Dose*, 5 to 30 gr.
2. **Potassii Bromidum.**—See *Potassium. Dose*, 5 to 30 gr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION.

Externally bromine is a powerful **irritant and escharotic.** Its local use is confined to the treatment of cancer of the cervix uteri (1 in 5 parts of rectified spirit). The bromides have no such irritant action unless in highly concentrated solution; nor are they absorbed from the unbroken skin.

Internally, the local action of bromine resembles that of chlorine, the vapour being intensely irritant, and, indeed, irrespirable. It is never used in this way.

The bromides taken continuously for a time in full doses, or applied in strong solution to the throat, are said to reduce the sensibility of the fauces, so that the reflex movements of the parts, such as swallowing, vomiting, cough, etc., are not easily excited; and they may therefore be employed previous to important examinations or operations in connection with the larynx, or in excessive irritability of the parts. The bromides have but little effect of an irritant kind on the stomach or bowels, so that large doses (20 grains thrice a-day for years) may be readily borne. The greatest care must always be taken, however, to preserve the digestion and regularity of the bowels, in cases where bromides are continuously taken.

2. ACTION IN THE BLOOD.

Bromide of potassium enters the blood unchanged, where it is probably converted into the sodium salt by double decomposition with the chloride of sodium. For a moment it may be free in the blood, but no special action or therapeutic application can be referred to this circumstance.

3. SPECIFIC ACTION AND USES.

The bromides pass through the organs as such or as bromide of sodium, and have a very definite specific action upon them, which, speaking generally, is one of depression.

The *nervous system* is specially affected. **Loss of reflex excitability** in connection with all the sentient surfaces of the body follows the administration of full medicinal doses. This result is due partly to depression of the peripheral (sensory) nervous filaments, but chiefly to reduced activity of the nervous centres in the brain and cord. At the same time the motor nerves are also soothed, and the *muscular* power (which we may conveniently consider along with the nervous), is much weakened. The phenomena of this general nervo-muscular depression are as follows, beginning with the highest centres: (1) The bromides lessen mental activity, readiness to react to emotional stimuli, and sensibility and irritability of mind generally, thus inducing a condition of brain favourable to the advent of sleep. They are thus indirect **hypnotics,** not acting like opium and chloral, but so reducing the patient's sensibility of his surroundings, bodily condition, or circumstances, as to prevent distraction, and allow natural sleep to intervene. It is uncertain whether the bromides act upon the nerve cells directly, or upon the cerebral blood-vessels. The soothing and hypnotic effects of the bromides are very extensively employed in restlessness and sleeplessness from mental strain, whether emotional or intellectual, in the acute specific fevers when similar symptoms are urgent, in acute alcoholism, and in mania. In the three last conditions a certain amount of chloral or opium may be advantageously combined with the bromides. Bromide of lithium, the most active hypnotic of the bromides, will sometimes remove the insomnia of gout. The most important application of the soothing action of the bromides is in **epilepsy,** which is now almost exclusively treated with these salts, unless they be contra-indicated. Hysteria, infantile convulsions, whooping-cough, general "nervousness," hypochondriasis, and the low despondent condition so common in women with uterine irregularities, are also relieved by bromides, although not with the success obtained in epilepsy.

The great vital centres of the *medulla* are depressed by bromides. Respiration becomes slower and is weakened, whence possibly part of the value of the drug in whooping-cough. The heart is also slower and weakened in its action; chiefly, however, by depression of its nervo-muscular substance, not of the cardiac centre. Bromides are of much service, therefore, in nervous disorder of the heart, especially in hysterical, dyspeptic, and alcoholic subjects. The direct effect of these drugs on the vessels is unsettled; as a whole, the tension is reduced.

The **spinal centres, and spinal nerves and muscles, are all depressed** by the bromides, the former so much so that the convulsions of strychnia poisoning cannot be induced, and the two drugs are so far physiological antagonists. In such a case and in tetanus the bromides may be given, but are neither rapid nor powerful enough to be trusted to alone.

The temperature is lowered by bromides, but not to an extent of much practical value.

The ovarian and uterine functions are quieted, and menorrhagia relieved, by the same drugs.

4. REMOTE LOCAL ACTION AND USES.

The bromides appear in the secretions within a few minutes after their administration, being eliminated by the kidneys chiefly, by the salivary glands, mammæ, skin, and all mucous surfaces. In passing through these excreting organs, the bromides break up and set free bromine, which exerts a remote stimulant effect on the parts. The composition of the urine is irregularly disordered; but not in a manner that can be turned to therapeutical account. The **skin** is markedly affected, a characteristic acne-like **eruption** appearing, or other forms of skin disease, which are familiar in epileptics consuming large quantities of the drug. Cough is occasionally set up, and conjunctivitis may also occur. The interest to the therapeutist of all these remote effects of the bromides lies in their prevention, if possible, in cases where the drugs have to be steadily taken for an indefinite time, an end which may sometimes be secured by combining them with arsenic.

Acidum Hydrobromicum Dilutum.—Diluted Hydrobromic Acid (U.S.P.). (*Not Officinal.*) A liquid composed of 10 per cent. of absolute Hydrobromic Acid, HBr, and 90 per cent. of Water.

Source.—By decomposing Bromide of Potassium by Sulphuric Acid, and distilling. $2KBr + H_2SO_4 = 2HBr + K_2SO_4$.

Characters.—A clear colourless liquid, odourless, with a strong acid taste and acid reaction.

Dose.—20 min. to 2 fl.dr.

ACTION AND USES.

Hydrobromic acid possesses many of the properties of the bromides, but is less useful than bromide of potassium. It is said to prevent the cerebral symptoms produced by quinine, which it readily dissolves, and the after-effects of morphia, if given with these drugs.

SULPHUR. SULPHUR. S. 32.

An elementary body found native as virgin sulphur, also as sulphides of metals.

Sulphur Sublimatum.—Sublimed Sulphur.

Source.—Prepared from crude or rough sulphur by sublimation.

Characters.—A gritty powder, of a fine greenish-yellow colour, without taste or odour until heated. Insoluble in water, soluble in oils and turpentine with heat.

Impurities.—Sulphurous and sulphuric acid; acid to test-paper. Arsenic, detected by agitating with ammonia, and evaporating. Earthy matters.

Dose.—20 to 60 gr.

Preparations.

a. Confectio Sulphuris.—Sublimed Sulphur, 4; Acid Tartrate of Potash, 1; Syrup of Orange Peel, 4.

Dose.—60 to 120 gr.

b. Unguentum Sulphuris.—Sublimed Sulphur, 1; Benzoated Lard, 4.

From Sulphur Sublimatum are made:

c. **Sulphur Præcipitatum.**—Precipitated Sulphur, "Milk of Sulphur."

Source.—Made by (1) boiling Sublimed Sulphur with Slaked Lime in water; (2) precipitating the filtrate with Diluted Hydrochloric Acid, washing and drying. (1) $6S_2 + 3CaH_2O_2 = 2CaS_5 + CaS_2H_2O_4 + 2H_2O$. (2) $2CaS_5 + CaS_2H_2O_4 + 6HCl = 6S_2 + 3CaCl_2 + 4H_2O$.

Characters.—A greyish-yellow soft powder, free from grittiness and smell of SH_2.

Impurities.—Sulphate of lime; detected microscopically as crystals. Sulphuretted hydrogen; detected by odour.

Dose.—20 to 60 gr.

d. **Potassa Sulphurata.**—Sulphurated Potash. See *Potassium.*

Preparation.

Unguentum Potassæ Sulphurata.—1 in 15½.

e. **Sulphuris Iodidum.**—Iodide of Sulphur, SI.

Source. — Made by fusing Sublimed Sulphur with Iodine.

Characters.—Greyish-black crystalline pieces. Solubility, 1 in 60 of glycerine; insoluble in water.

Preparation.

Unguentum Sulphuris Iodidi.—1 in 15½.

Sublimed Sulphur is also contained in Emplastrum Hydrargyri, and Emplastrum Ammoniaci cum Hydrargyro.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally applied, sulphur has probably no local action of itself, but is partially converted, by contact with the acid products of the skin, into sulphuretted hydrogen and sulphides, which are energetic substances. Whether, therefore, rubbed on as ointment, worn in flannel, distributed over the surface by fumigation, or given as a natural or artificial bath of "sulphur waters," it is not sulphur, but its hydrogen compound, which possesses local therapeutical properties.

Sulphuretted hydrogen, when brought in contact with the skin in any of the forms just mentioned, is a **vascular stimulant and nervous sedative.** It is probably on this account that sulphur has long been regarded as useful in relieving the pains of chronic rheumatism; and as an **alterative** in certain kinds of skin disease such as acne, in which the ointment of the Potassa Sulphurata is especially valuable. The solution of the gas is also absorbed by the skin, and is extolled (in the form of baths) in lead and mercury poisoning, syphilis, and chronic enlargements of joints. The *rationale* of these effects will be discussed under the head of its specific action.

Sulphur and sulphurated potash destroy the *Acarus scabïei*, and are used in the treatment of itch.

Internally, sulphur has been locally applied to the throat in diphtheria, but with disappointing results.

In the stomach it remains unaltered, and passes as such into the intestines, where it acts as a purgative, possibly by increasing peristalsis, more probably by stimulating the glandular structures. Medicinal doses of milk of sulphur, the Confectio, or the German Pulvis Glycyrrhizæ Compositus, are simple **laxatives**, producing an easy soft stool with little or no pain. Sulphur waters, drunk freely at Harrogate, Moffat, and Strathpeffer in this country, at Aix-la-Chapelle, Challes, Aix-les-Bains, and the Pyrenees, on the continent of Europe, and at the Blue Lick, Alpena, Sharon, and other springs in the United States, have a similar but more powerful effect, producing considerable disturbance of the bowels, and depressing the portal circulation. Sulphur and sulphur waters are extensively used as purgatives in congestion of the rectum and liver, hæmorrhoids, and other diseases of the great bowel; and the waters and baths combined are powerful evacuants and alteratives in plethora, hepatic engorgement, and gravel.

Sulphur escapes in a great measure unabsorbed in the fæces, partly unchanged, partly as sulphides of hydrogen and the alkalies which it has encountered in the bowel, the activity of purgation varying indirectly with the degree of absorption.

2. ACTION ON THE BLOOD.

The amount of sulphur which enters the blood in the form of sulphides of hydrogen and the alkalies, under the use of sulphur or sulphur waters, is usually insignificant. When inhaled into the circulation, sulphuretted hydrogen is a powerful blood-poison, acting both on the red corpuscles and the serum; it reduces the oxyhæmoglobin of the former, and converts the carbonates and phosphates of the latter into sulphides, sulphites, and sulphates; but this subject is not of therapeutical interest.

3. SPECIFIC ACTION AND USES.

The hydrogen and alkaline sulphides pass into the tissues from the blood, and act chiefly upon the central nervous system. When in large quantity, they induce rapid failure of the nerve centres, especially those of respiration and circulation, the subject dying rather of asphyxia than from the poisonous influence on the blood just described. It is possible that the headache and nervous depression which attend the use of sulphur waters in some persons are minor degrees of these effects. It is possible also that sulphur and its compounds, possessing these powerful influences on the blood and tissues (which appear to be of the nature of arrest of oxydation), may modify nutrition to some extent even in medicinal doses, and thus possess **alterative** properties. In chronic rheumatism, syphilis, gout, and skin disease they have been much prescribed from time immemorial, especially at watering places. Sulphide of calcium has lately been found useful in scrofulous disease of bones.

4. REMOTE LOCAL ACTION AND USES.

It is under this head that we find the principal suggestions for the therapeutical employment of sulphur. The sulphides which we have traced through the blood and tissues are variously excreted. By the kidneys they pass out as sulphates, and it is said that one half of a dose of Sulphur Præcipitatum can be thus recovered from the urine, but only one-fifth of Sulphur Sublimatum. If in excess, part is also excreted as sulphides. No special use is made of these facts. By the skin they escape as sulphides, giving the characteristic foul odour to the perspiration, and somewhat increasing its amount. Sulphur is used as a **mild cutaneous stimulant and diaphoretic**, and has always been regarded as a valuable internal remedy for many skin diseases, such as acne, chronic eczema, psoriasis, and syphilitic eruptions. Drinking the waters and taking the baths at sulphur springs probably act in this remote local way. Sulphide of calcium is specially useful in boils. The sulphides are also excreted by the bronchi and lungs, giving their odour to the breath; sulphur was once much used as an **expectorant,** especially in chronic bronchitis with abundant expectoration and gouty or rheumatic associations.

The valuable effect of sulphur waters, taken internally and used as baths, in cases of chronic rheumatism, gout, skin disease, plethora, etc., is principally, if not entirely, to be accounted for by the immediate and remote local action of the sulphides—on the bowels and portal system, and on the kidneys, skin, and bronchi respectively. It is an important fact that sulphur is a **purgative alterative.**

CARBO. CARBON. C. 12.

Two kinds of carbon are officinal, namely, animal charcoal and wood charcoal.

1. Carbo Animalis.—Animal Charcoal. Bone Black.

Source.—Made by exposing bones to a red heat without the access of air.

Characters.—A black powder; contains only 10 per cent. of pure carbon, the rest consisting chiefly of phosphate and carbonate of lime.

Preparation.

Carbo Animalis Purificatus.—Purified Animal Charcoal. Animal Charcoal from which the salts have been almost wholly removed.

Source.—Made by digesting Animal Charcoal in

Diluted Hydrochloric Acid, washing the undissolved part, and heating to redness in a closed crucible.

Characters.—A black powder, inodorous, and nearly tasteless.

Dose.—20 to 60 gr.

2. Carbo Ligni.—Wood Charcoal.

Source.—Wood charred by exposure to a red heat without access of air.

Characters.—Black, brittle, porous masses, without taste or smell, and retaining the texture of wood; contains about 2 per cent. vegetable ash.

Dose.—20 to 60 gr.

Preparation.

Cataplasma Carbonis.—Wood Charcoal, Linseed Meal, Bread Crumb, and boiling Water.

Charcoal is also used pharmaceutically as a decolorising agent, in the preparation of such drugs as morphia and atropia.

ACTION AND USES.

Externally.—Charcoal absorbs and condenses many gaseous bodies and vapours, as oxygen, carbonic acid, etc., and attracts the colouring, odoriferous, and sapid principles of many liquid substances, for example, litmus, bitters, wines, and decomposing liquids in general. It is used as a **deodorant** and **disinfectant** to absorb the foul emanations from cancerous and other discharges, ulcers, and wounds, being either hung around the bed in bags, or directly applied in dust, or as the poultice (a bad form.)

Internally.—Charcoal is locally used as a dentifrice. When taken into the stomach in sufficient bulk, either pure, or in the form of biscuits, it absorbs any gas and acrid products of indigestion which may be distending and distressing the organ, and is useful as a **carminative** in some forms of flatulent dyspepsia. Animal charcoal has been recommended by Dr. Garrod as an **antidote** in poisoning by opium, nux-vomica, aconite, and other organic poisons, which it attracts from their solutions in the stomach, and renders inert. It is doubtful, however, whether the absorptive action of charcoal can be retained in the bowel, or even in the stomach, after it has been thoroughly brought in contact with water. In the intestines it may possibly reduce flatulence, deodorise the fæces, and thus reduce the reflex peristaltic movements, and relieve diarrhœa.

Charcoal is entirely evacuated by the bowel and is not absorbed, so that it exerts no specific action on the body.

GROUP IV.

THE ACIDS.

The officinal acids may be classified as follows :

1. Inorganic Acids. — Acidum Sulphuricum, A. Nitricum, A. Hydrochloricum, A. Nitrohydrochloricum Dilutum, A. Phosphoricum Dilutum, A. Sulphurosum, A. Arseniosum. Of these, Acidum Arseniosum is described under *Arsenic*, and Acidum Sulphurosum under its own heading.

2. Organic Acids.—Acidum Aceticum, A. Citricum, A. Tartaricum, A. Hydrocyanicum Dilutum, A. Carbolicum, A. Benzoicum, A. Gallicum, and A. Tannicum. Of the organic acids, the first three only will be discussed here ; the action and uses of the other substances being but little connected with their properties as acids.

ACIDUM SULPHURICUM, NITRICUM, HYDROCHLORICUM, NITROHYDROCHLORICUM DILUTUM, PHOSPHORICUM DILUTUM, ACETICUM, CITRICUM, AND TARTARICUM.

These substances all possess distinctly acid properties, that is, they neutralise alkalies, and turn blue litmus red.

Acidum Sulphuricum.—Sulphuric Acid. H_2SO_4 98 per cent., = 79 per cent. SO_3, in water.

Source.—Obtained by the combustion of Sulphur, and oxydation by nitrous fumes.

Characters. — A colourless, oily-looking, intensely acid liquid.

Impurities.—Nitric acid, lead, and arsenic, organic matter ; detected by colour.

Preparations.

1. **Acidum Sulphuricum Dilutum.**—1 to about 11 of Distilled Water. *Dose,* 5 to 30 min.

From Acidum Sulphuricum Dilutum is prepared :
Infusum Rosæ Acidum. 1 of Diluted Acid in 80.

2. **Acidum Sulphuricum Aromaticum.**—1 to about 13 of Spirit, with Cinnamon and Nutmeg. *Dose,* 5 to 30 min.

3. Many Sulphates and other preparations.

Acidum Nitricum.—Nitric Acid. HNO_3, 70 per cent. by weight, in Water.

Source.—Prepared from Nitre by distillation with Sulphuric Acid and Water.

Characters.—A colourless, intensely acid fuming liquid.

Impurities.—Sulphuric and hydrochloric acids; mineral matter; excess of water; peroxide of nitrogen; known by yellow fumes.

Preparations.

1. **Acidum Nitricum Dilutum.**—1 to fully 4 of Distilled Water. *Dose*, 10 to 30 min.

2. **Acidum Nitrohydrochloricum Dilutum.**—3 to 25 of Distilled Water, with 4 of Acidum Hydrochloricum. *Dose*, 5 to 20 min.

3. Many Nitrates and other preparations.

Acidum Hydrochloricum.—Hydrochloric Acid. HCl, 31·8 per cent. by weight, dissolved in Water.

Source.—Obtained by the action of Sulphuric Acid upon Chloride of Sodium, and the solution of the resulting fumes.

Characters.—A nearly colourless, very acid liquid, with pungent odour.

Impurities.—Sulphuric and sulphurous acids, arsenic, and water; detected by ordinary tests.

Preparations.

1. **Acidum Hydrochloricum Dilutum.**—1 to 2¼ of Distilled Water. *Dose*, 10 to 30 min.

2. **Acidum Nitrohydrochloricum Dilutum.**—4 to 25 of Distilled Water, with 3 of Acidum Nitricum. *Dose*, 10 to 30 min.

3. Many Chlorides, and other preparations.

Acidum Phosphoricum Dilutum. — Diluted Phosphoric Acid. H_3PO_4 dissolved in Water = 10 per cent. P_2O_5.

Source.—Made by distilling Phosphorus with Nitric Acid and Water, heating, and diluting.

Characters.—A colourless sour liquid, with a strongly acid reaction.

Impurities.—Arsenic and lead; detected by H_2S. Sulphuric, nitric, hydrochloric, and pyro- and meta-phosphoric acids; detected by usual tests.

Incompatibles.—Lime-water, calcareous salts, and carbonate of soda.

Dose.—20 to 30 min.

Diluted Phosphoric Acid is used in preparing Syrupus Ferri Phosphatis, and Ammoniæ Phosphas.

Acidum Aceticum.—Acetic acid. Anhydrous Acetic Acid, $C_4H_6O_3$, 28 parts in Water.

Source.—Prepared from Wood by destructive distillation and purification.

Characters.—A colourless liquid, with a pungent odour and strong acid reaction.

Impurities.—Lead, copper; sulphuric, hydrochloric, and sulphurous acids.

Preparations.

1. **Acidum Aceticum Dilutum.**—1 volume to 7 of Water. *Dose*, 1 to 2 fl.dr.
2. **Oxymel.**—Acetic Acid, 1; Water, 1; Honey, 8.

Dose.—3 to 6 dr.

Acetic Acid is also used in preparing Acetum Cantharidis, Acetum Scillæ, Extractum Colchici Aceticum, Linimentum Terebinthinæ Aceticum, Liquor Epispasticus, and many Acetates.

Acidum Aceticum Glaciale.—Glacial Acetic Acid. $C_4H_6O_3$, 84 per cent. in Water.

Source.—Made by distillation from Acetate of Soda and Sulphuric Acid.

Characters.—A colourless acid liquid, with a powerful acetic odour.

Impurities.—Sulphurous acid; and water.

Glacial Acetic Acid is used in preparing Acetum Cantharidis, and Mistura Creasoti.

Acetum.—Vinegar.

Source.—Prepared from Malt and Unmalted Grain by acetous fermentation.

Characters.—A brown-coloured acid liquid, with a characteristic odour.

Impurity.—Excess of sulphuric acid; detected volumetrically.

Dose.—1 fl.dr. and upwards.

Vinegar is used in preparing Emplastrum Cerati Saponis.

Acidum Citricum.—Citric Acid. $H_3(C_6H_5O_7)H_2O$.

Source.—Obtained from the juice of the Lemon (*Citrus Limonum*), or of the Lime (*Citrus Limetta*), by neutralising it with Chalk, decomposing the Citrate of Lime thus formed by Diluted Sulphuric Acid, purifying, and crystallising.

Characters.—Colourless crystals, in the form of right rhombic prisms. Very soluble in water. 17 gr. in ½ fl.oz. of water make a solution resembling lemon juice in strength and acidity, and exactly neutralise 25 gr. of Potassæ Bicarbonas, 20 gr. of Sodæ Bicarbonas, or 15 gr. of Ammoniæ Carbonas.

Impurities. — Copper, sulphuric acid, mineral matters. Tartaric acid, detected by precipitate with acetate of potash.

Dose.—10 to 30 gr.

Citric Acid is used in preparing Ferri et Ammoniæ Citras, Ferri et Quiniæ Citras, and Vinum Quiniæ.

Acidum Tartaricum.—Tartaric Acid. $H_2(C_4H_4O_6)$.

Source.—Obtained from Acid Tartrate of Potash by neutralising its solution with (1) Chalk and (2) Chloride of Calcium, (3) decomposing the Tartrate of Lime thus formed by Sulphuric Acid, and purifying. (1) $2KHC_4H_4O_6 + CaCO_3 = CaC_4H_4O_6 + K_2C_4H_4O_6 + H_2O + CO_2$. (2) $K_2C_4H_4O_6 + CaCl_2 = CaC_4H_4O_6 + 2KCl$. (3) $2CaC_4H_4O_6 + 2H_2SO_4 = 2H_2C_4H_4O_6 + 2CaSO_4$.

Characters.—Colourless oblique rhombic prisms, with a strongly acid taste, readily soluble in water. 20 gr. exactly neutralise 27 gr. of Potassæ Bicarbonas, 22 gr. of Sodæ Bicarbonas, or 15½ gr. of Ammoniæ Carbonas.

Impurities.—Lead, oxalic acid, lime, mineral matter, acid tartrate of potash.

Dose.—10 to 30 gr.

Tartaric Acid is used in preparing Sodæ Citrotartras Effervescens.

Carbonic Acid.—Although not officinal as such, carbonic acid gas is extensively used in medicine, being obtained from Bicarbonates and Carbonates, commonly of Soda, Potash, or Ammonia, by decomposition with Citric or Tartaric Acid. The process is known as *effervescence.* The reaction may be thus represented:

$$\underset{\text{Sodæ Bicarbonas}}{3(NaHCO_3)} + \underset{\text{Acidum Citricum}}{(C_6H_5O_7)H_3} = \underset{\text{Sodæ Citras}}{Na_3(C_6H_5O_7)} + \underset{\text{Carbonic Acid}}{3CO_2} + \underset{\text{Water.}}{3(H_2O)}.$$

ACTIONS AND USES.

1. IMMEDIATE LOCAL ACTIONS AND USES.

Externally. Acids are irritants, and some of them very powerful corrosives. The strong acids are used as **caustics**;

nitric acid to destroy chancres; acetic acid, warts; sulphuric acid, some forms of malignant growths. Very dilute watery solutions, sponged on the skin in fever, cool the surface by evaporation, and thus act as **refrigerants**; whilst watery solutions of sulphuric acid used in this way appear to constringe the tissues, and diminish the sweating of phthisis.

Internally.—In the dilute form, acids act directly upon the contents of the alimentary canal, and are used in the treatment of poisoning by alkalies. In every instance the free acids quickly unite with bases in the digestive tract, and form neutral salts. In the mouth they are **stimulants and sialagogues**: they relieve thirst, rouse the appetite, and aid digestion by increasing the flow of saliva and gastric juice, the citrates, tartrates, and acetates being chiefly used for this purpose as acid drinks and fruits of great variety, *e.g.* in fever. In the stomach hydrochloric acid increases the acidity of the gastric juice, and is given for this purpose during or after meals, as a powerful **stomachic.** Carbonic acid, introduced in effervescing wines and waters, has a grateful sedative action upon the gastric nerves; and in the form of champagne and effervescing mixtures is a most valuable remedy in the treatment of sickness with exhaustion. The other acids assist gastric digestion but to a very small, possibly useless, extent. Reaching the duodenum, acids **increase the acidity of the chyme and stimulate the liver, pancreas, and intestinal muscles and glands.** Dilute nitric and nitrohydrochloric acids, given at the end of meals, are therefore used as **cholagogues** in intestinal dyspepsia with hepatic torpidity, especially in tropical cases.

2. ACTIONS ON THE BLOOD AND THEIR USES.

Acids **render the blood less alkaline** (but never acid, even in poisonous doses), by combining with part of the alkali of the liquor sanguinis. No special use is made of this property. Phosphoric acid increases the phosphates in the red corpuscles, and is thus **hæmatinic.** The vegetable acids, when given as salts of the alkalies, have an important **deoxydising** effect on the blood. For example, citrate of potash becomes converted in the blood into carbonate of potash, carbonic acid, and water, a portion, however, of the citric acid always remaining unoxydised (see *Potassium*), thus: $2(K_3C_6H_5O_7) + O_{18}$ (in blood) $= 3(K_2CO_3) + 5H_2O, + 9CO_2$. Citrates, tartrates, and acetates of potash, soda, ammonia, etc., in the effervescing form, may therefore be used to set free in the blood the carbonates of the alkalies, which cannot be so conveniently or safely given in large doses by the stomach. The vegetable acids have been used in the treatment of scurvy, apparently with doubtful success; and in rheumatism, with equally questionable results, beyond their action on the mouth, skin, and kidneys.

3. SPECIFIC ACTIONS AND USES.

In the tissues and organs each of the acids exhibits a specific action of its own. *Sulphuric Acid* is an **astringent** to the bowels, skin, and blood-vessels, and is a valuable remedy for diarrhœa, profuse sweating, and hæmorrhage. *Nitric* and *Nitrohydrochloric Acids* are **cholagogue**, specifically as well as locally; *e.g.* when administered by means of a foot-bath (8 fl.oz. to one gallon of water), or of a compress wrung out of the solution and worn over the hepatic region. Tropical enlargements of the liver may thus be reduced. The **tonic** influence of these acids is probably referable to their stimulating effect upon the gastric and biliary functions. *Hydrochloric Acid* enters the tissues as chlorides, and no specific action or use can therefore be credited to the small doses which can be given of it. *Phosphoric Acid* also possesses no further influence on the tissues than that of increasing *pro tanto* the amount of phosphates, and possibly the growth of bones; and its value in constitutional diseases is probably due to its action on the red corpuscles, and to the bases with which it is combined (iron, lime, etc.). As we have seen, *Acetic*, *Citric*, and *Tartaric Acids* never reach the tissues, being decomposed in the blood, unless given in large doses.

4. REMOTE LOCAL ACTIONS AND USES.

The acids, having chiefly entered into combination as neutral salts, or having been decomposed in the blood, produce remarkably little local action when they are escaping from the body in the secretions. *Sulphuric* acid is excreted chiefly by the kidneys, increasing very slightly the normal amount of sulphates; part escapes by the bowels as sulphates; part by the skin, this acid being **anhidrotic.** *Phosphoric* and *Hydrochloric* acids behave similarly. *Nitric* acid is believed to be partly decomposed into ammonia, and thus actually to diminish, to a slight degree, the acidity of the urine. *Acetic*, *Tartaric*, and *Citric* acids pass out of the body as carbonates, unless in excess, when they escape unchanged by the kidneys. The important point to be noted about all these acids, therefore, is, that **they do not, to any considerable or useful extent, increase the acidity of the urine.** It must be observed, however, that all the acids probably stimulate the kidneys and skin indirectly, by increasing the total amount of salts excreted by them.

Acidum Boricum.—Boric Acid. Boracic Acid. BO_3H_3. (*Not Officinal, except as a test.*)

Source.—Sodæ Biboras, by the action of sulphuric acid.

Characters.—In white glittering plates, odourless, with a slightly bitter taste. A weak acid. Solubility, 1 in 26 of cold water, 1 in 3 of hot water; freely in glycerine; less freely in spirit.

Dose.—5 to 30 gr.

Preparations.

1. "Boracic Lint." Lint steeped in a boiling saturated solution, and dried. Contains nearly half its weight of the acid.
2. Various Ointments and Lotions.

ACTION AND USES.

Externally, boracic acid destroys low organisms, a solution of 1 in 133 arresting the activity of bacteria, and it is thus an **antiseptic, disinfectant, and deodorant**. On the tissues it produces little or no irritation, and is thus peculiarly adapted for use as a surgical dressing. The lint is now extensively employed in the antiseptic system; and lotions, warm fomentations made from a boiling saturated solution, and ointments with paraffin and vaseline, have almost replaced for the time other applications to wounds and ulcers. As its action does not extend beyond the surface to which it is applied, boric acid is never used for dressing cavities. It relieves itching, in the form of a powder, ointment, or glycerine. It is a test for Rheum (q.v.).

Internally, boric acid is a gastro-intestinal irritant in large doses.

Acidum Sulphurosum.—Sulphurous Acid. Sulphurous acid gas, SO_2, dissolved in water, and constituting 9·2 per cent. by weight of the solution (rarely contains more than 5 per cent.).

Source.—Made by heating sulphuric acid with charcoal, and dissolving the gas in water. $4H_2SO_4 + C_2 = 4SO_2 + 2CO_2 + 4H_2O$.

Characters.—A colourless liquid, with a pungent sulphurous odour.

Impurities.—Sulphuric acid; mineral matters; excess of water, detected by volumetric starch and iodine test.

Dose.—$\frac{1}{2}$ to 1 fl.dr.

Non-officinal Preparations containing Sulphurous Acid.

Sodæ Sulphis.—Sulphite of Soda. $Na_2SO_3,7H_2O$.

Source.—Made by saturating a solution of carbonate of soda with sulphurous acid gas.

Characters.—White efflorescent prisms, with a sulphurous taste; feebly alkaline. Soluble in 4 parts of water.

Dose.—5 to 20 gr.

Sodæ Hyposulphis.—Hyposulphite of Soda. $Na_2H_2S_2O_4.4H_2O$.

Source.—Made by passing Sulphurous Acid gas into a solution of Carbonate of Soda, with Sulphur. $2Na_2CO_3 + S_2 + 2SO_2 + 2H_2O = 2(Na_2H_2S_2O_4) + 2CO_2$.

Characters.—Large colourless transparent crystals, odourless, with a cool, bitter, sulphurous taste. Soluble in 1½ parts of water. The solution is an officinal test for I and Cl.

Dose.—10 to 60 gr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Sulphurous acid is a powerful **deoxydising** agent. Seizing on oxygen and water, it decomposes organic bodies, and at the same time produces upon them the **irritant** local effects of sulphuric acid, into which it is converted. It thus destroys low forms of living matter, including the organisms associated with fermentation, decomposition, and certain diseases, 1 part in 666 of water being sufficient for this purpose. Sulphurous acid is therefore applied to ringworms and foul wounds; and some kinds of sore throat are relieved by a spray of the officinal acid. Morbid fermentation in the stomach attended by the growth of organisms, such as *penicillium* and *sarcina*, may be quickly arrested by doses of min. 5 to min. 60 of the officinal acid; but the non-officinal salts are more convenient forms for internal use, being decomposed by the acids of the stomach. Sulphites given in full doses become converted into sulphates, and act as purgatives.

Sulphurous anhydride, although not officinal, is very extensively used for fumigating infected rooms and clothing, being probably the most powerful, certain, and convenient of all **disinfectants**. Sulphur is burned on a shovel or plate, the outlets from the room having been carefully closed, excepting the door through which retreat is made.

2. ACTION ON THE BLOOD, AND SPECIFIC ACTION AND USES.

Sulphites were once supposed to enter the blood and tissues, and to arrest morbid fermentation or fever processes within them. The evidence, however, is to the effect that sulphites are not absorbed as such, but as sulphates, and the benefit derived from them in fevers is probably due to the laxative and diuretic effects of the higher salts. The suggested decomposition of hyposulphites into sulphites and free sulphur, and their consequent alterative and disinfectant action in phthisis and other diseases, appear to be equally unreal.

3. REMOTE LOCAL ACTION.

Sulphites are excreted by the urine and bowels in the form of sulphates.

Acidum Nitrosum.—Nitrous Acid. HNO_2. (*Not Officinal.*)

This acid is not itself used in medicine, but the nitrites are active and valuable drugs. Those in use are nitrite of sodium and nitrite of amyl, as well as sweet spirit of nitre and nitroglycerine. The sodium salt will be noticed here; the others under their own heads.

Sodii Nitris.—Nitrite of Sodium. $NaNO_2$. (*Not Officinal.*)

Source.—Made by heating nitrate of soda. $2NaNO_3 = 2NaNO_2 + O_2$.

Characters.—A white granular powder, deliquescent, with a cool saline taste, very soluble in water.

Impurities.—The nitrate, and caustic soda.

Dose.—2 to 10 grains.

ACTION AND USES.

Nitrite of sodium acts upon the blood, the heart, and vessels **like nitrite of amyl,** only less suddenly and markedly, and for a much longer period of time. It has been used with success in heart disease, with recurrent attacks of painful angina; less successfully in epilepsy. Its depressant action on the central nervous system is more marked than that of the amyl compound; and it also paralyses the peripheral nerves and the muscles not only in this way, but through the blood.

GROUP V.

WATER.

AQUA. WATER.

Natural water, the purest that can be obtained, cleared, if necessary, by filtration, and free from odour, taste, and visible impurity.

From Aqua is made :

Aqua Destillata.—H_2O. Pure water, obtained by distillation.

Preparations.

Very numerous throughout the whole Pharmacopœia.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, water acts chiefly as a means of applying heat or cold to the surface of the body, being readily obtained at any temperature that may be desired. To produce this effect, water may be applied in the form of **baths** of all kinds : Cold, cool, temperate, tepid, warm, hot, vapour, or variously medicated ; also by sponging, douching, fomenting, etc. These subjects will be noticed in the third part of the work. Possessing these properties, water is used externally for purposes of cleanliness ; for either raising or lowering the temperature of the body ; relieving pain, insomnia, and delirium ; removing spasms or convulsions ; diminishing the circulation in deep parts by superficial "derivation," as in congestion of the brain, etc. Water is also used, in a purely local way, as a wash or dressing to wounds, and as the basis of warm fomentations in inflammations.

Internally, water is constantly being taken in the form of food and drink. It relieves thirst, improves digestion and intestinal action when drunk in moderation and at proper times, and in a purely physical way may reduce the local or general temperature of the body, for instance, as ice slowly sucked in sore throat and febrile conditions.

2. ACTION ON THE BLOOD.

Water is quickly incorporated with the circulating plasma. Great excess has been known to dissolve part of the red corpuscles, but this is a purely pathological effect.

3. SPECIFIC ACTION AND USES.

Water plays an essential part in tissue life and in the activity of all the organs. A copious supply of water increases nutrition up to a certain point, especially the deposit of fat, and is therefore extensively employed in hydro-therapeutics.

4. REMOTE LOCAL ACTION AND USES.

Water is excreted by the kidneys, skin, lungs, bowels—indeed, necessarily in every secretion. Increase of water in the urine is most readily induced when the skin is kept cool, and carries with it an excess of urea, phosphoric acid, and chloride of sodium. Water is thus a **diuretic**, and in one sense the most natural measure of the kind, being indicated when we desire simply to irrigate or flush the uriniferous tubules and urinary passages, and wash from them the products of disease, such as blood, leucocytes, cellular *débris*, and sediments. Some kinds of calculi may be dissolved by the steady consumption of distilled water, which carries away minute traces of the stone, whilst it prevents fresh accretion on the surface.

As a **diaphoretic**, water acts best when warm and combined with external heat. It is the basis of most familiar domestic measures for relieving feverishness by inducing perspiration, such as warm drinks of all kinds, and spirituous compounds.

GROUP VI.

THE CARBOHYDRATES AND OTHER CARBON COMPOUNDS.

ALCOHOL. ALCOHOL. C_2H_6O.

Besides the following preparations, which are commonly associated with alcohol, all the Tincturæ, Spiritûs, and Essentiæ, several of the Liquores, Linimenta, and Misturæ, and a few other compounds contain it in various proportions.

1. Alcohol.—Absolute Alcohol. C_2H_6O. Used only in chemical testing.

Source.—Made by shaking rectified spirit with carbonate of potash; decanting, and distilling with slaked lime.

Characters.—Colourless, free from empyreumatic odour. Sp. gr., 0·795.

Impurities.—Resins, or oil; detected by turbidity on dilution. Water; giving blue colour with anhydrous sulphate of copper.

2. Spiritus Rectificatus.—Rectified Spirit. Alcohol, C_2H_6O, with 16 per cent. of water.

Source.—Obtained by the distillation of fermented saccharine fluids.

Characters.—Colourless, transparent, with a pleasant odour, and strong spirituous burning taste. Specific gravity, 0·838.

Impurities.—Water; tested volumetrically. Amylic alcohol, beyond a trace; detected by excessive reduction of $AgNO_3$. Resin or oil; giving turbidity on dilution with water.

Preparation.

> **Spiritus Tenuior.** — Proof Spirit. Alcohol with 51 per cent. of water. Made by mixing 5 parts of rectified spirit with 3 parts of water. Specific gravity, 0·920.

3. Spiritus Vini Gallici.—Brandy. Spirit distilled from French wine.

Characters.—A spirit of a light sherry colour, and peculiar flavour; contains about 53 per cent. of *alcohol*, with some *volatile oil*, and *œnanthic ether*.

Preparation.

> Mistura Spiritus Vini Gallici.—"Brandy Mixture," "Egg Flip." Brandy and Cinnamon Water, of each 4 oz.; Yolks of two Eggs; Sugar, ½ oz. *Dose*, 1 to 2 fl.oz.

4. Vinum Xericum.—Sherry. A Spanish wine.

Characters.—Pale yellowish brown, containing 17 or 18 per cent. of *alcohol*; with *colouring matter*, *ethereal compounds*, *acid tartate of potash*, *malates*, *sugar*, *etc.*

Preparations.

> The following Vina: Aloes, Antimoniale, Colchici, Ferri, Ipecacuanhæ, Opii, Rhei.
>
> Vinum Aurantii is made by fermentation of a saccharine solution; Vinum Ferri Citratis and Vinum Quiniæ are made from Vinum Aurantii.

Amount of Alcohol (absolute, by weight) in the various substances containing it.

Absolute Alcohol.
Alcohol (U.S.P.), 91 per cent.
Spiritus Rectificatus, 84 per cent.
Alcohol Dilutum (U.S.P.), 45·5 per cent.
Spiritus Tenuior, 49 per cent.
Spiritus Vini Gallici (Brandy), about 39 to 47 per cent.
Spiritus Frumenti (Whisky), about 44 to 50 per cent.
Rum
Gin } about 40 to 50 per cent.
Strong Liqueurs

Port, Sherry, and Madeira, about 14 to 17 per cent.
Vinum Album Fortius (U.S.P.), about 11·5 to 14 per cent.
Vinum Album (U.S.P.), about 10 to 12 per cent.
Champagne, about 10 to 13 per cent.
Hock and Claret, about 8 to 11 per cent.
Beer and Cider, about 3, 5, or more per cent.
Koumiss (made from milk), about 1 to 3 per cent.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, alcohol is an **antiseptic** and **disinfectant**, employed as a constituent of lotions for ulcers and wounds. Applied to the unbroken skin, and the vapour allowed to escape, it is a powerful **refrigerant**, withdrawing heat from the body by its evaporation. In this form it is used to prevent or allay inflammations of superficial parts, such as the subcutaneous tissues, joints, and muscles; blanches the parts by vascular constriction; produces a sense of cold; and relieves pain, especially headache, due to vascular dilatation and throbbing. Spirituous lotions sponged on the skin also diminish the activity of the sweat-glands, and may be used in excessive perspiration as an anhidrotic. On the contrary, if the vapour be confined, and allowed to act upon the tissues underneath, or if the alcohol be rubbed into the part, it penetrates and hardens the epithelium, and irritates the nerves and vessels of the cutaneous structures, causing redness, heat, and pain, followed by local anæsthesia. In the form of brandy it is rubbed into the skin to prevent bedsores, by hardening and disinfecting the epidermis. Spirituous liniments containing soaps, essential oils, and other **stimulants** (*e.g.* Linimentum Camphoræ and Linimentum Camphoræ Compositum), are applied with friction to increase the nutrition of parts which are the seat of chronic inflammation, induration, adhesions, stiffness, and pain, such as the joints and muscles in chronic rheumatism, periostitis, and paralysis, or to produce a **rubefacient** effect on a large area of skin, for instance, of the chest in bronchitis. Alcohol is absorbed by the unbroken skin.

Internally, the local action of alcohol begins in the mouth with its characteristic taste and a hot, painful, stimulating effect on the tongue and mucous membranes. If it be retained in contact with them, the epithelium becomes condensed and whitened, and the parts beneath anæsthetised. Some forms of toothache can thus be quickly and completely relieved, the spirit also acting as a disinfectant in the pulp cavity. Wines and other wholesome alcoholic liquids consumed during meals have an action of the first importance on the nerves of the tongue, palate, and nose. By virtue of their taste, flavour, and bouquet, they give **a relish to food, increase the appetite, and stimulate the flow of saliva and the functions of the stomach.**

In the stomach the action of alcohol is complex, and of great importance. (1) Alcohol mixes with the *contents* of the stomach; is partly decomposed into acetic acid; and precipitates some of the proteids of the gastric juice: so far it depresses digestion. (2) It stimulates the *mucous membrane*, dilating and filling the vessels with blood; excites and markedly increases the flow of gastric juice; sharpens the appetite; and renders the movements of the viscus more energetic: in these respects it greatly assists digestion. The total effect of a moderate dose of alcohol is decidedly to **favour gastric digestion**, especially in cases where the nerves, vessels, and glands lack vigour, as in old age and in the chronic dyspepsia of persons weakened by acute illness, town life, and anxious sedentary employments. Herein consists the value of a small amount of wine or wholesome ale taken with meat meals by such subjects. The danger lies in excess, which readily destroys the activity of the juice, and also sets up a secretion of alkaline mucus which greatly interferes with digestion—a common cause of acute dyspepsia.

(3) The action of alcohol on the gastric wall produces extensive effects of a *reflex* kind. The heart is stimulated by moderate doses, producing a pleasurable rise of pressure and sense of power. The vessels dilate universally, filling the active organs with blood, further increasing their activity, the brain being specially excited, and the skin flushed and warmed subjectively. If the quantity be large these salutary effects of alcohol as a **diffusible stimulant** may pass into depression; and the sudden ingestion of a large amount of spirit may prove rapidly fatal by shock. The reflex results of alcoholic stimulants, if properly applied, add to its value at meal times, by increasing the enjoyment of eating, and thus the digestive power. Certain forms of pain in the stomach and bowels are rapidly relieved by the local action of brandy, which also helps to expel flatus; and pain, spasm, irregular or feeble action of the heart, cold feelings of the surface, and low conditions of the brain are all quickly removed by the same reflex means, before the alcohol could be absorbed in quantity into the blood.

2. ACTION ON THE BLOOD.

Alcohol enters the blood unchanged, and is distributed by it to the tissues and organs, a small part only becoming lost in it as acetic and carbonic acid. The action of alcohol on the corpuscles is still obscure, but it probably **binds the oxygen more firmly to the hæmoglobin,** so that oxygenation of the tissues occurs less freely, and therefore less extensively. The effect of this upon metabolism will now be described.

3. SPECIFIC ACTION.

Alcohol is rapidly taken up by the various organs, chiefly unchanged. If given in moderate quantity, it is (1) completely oxydised in its passage through the tissues into carbonic acid and water, like other carbohydrates, that is, it is a **food,** or source of heat and energy. At the same time it produces two other equally important effects; for (2) it **reduces the activity of metabolism** or the oxydation of the tissues; and (3) it first **stimulates,** and afterwards depresses, the circulatory and nervous systems, quite independently of its action on tissue-change. These three effects of alcohol must be discussed separately.

(1) *Alcohol as a food.*—It may now be accepted as proved that, when taken in sufficiently small quantities, **alcohol is oxydised in the tissues**; and that it only passes out of the body unchanged, through the lungs, kidneys, etc., when so freely given that excretion occurs before oxydation has had time to take place. This decomposition of alcohol must necessarily develop vital force and heat, like the oxydation of sugar, fat, and albumen. Alcohol belongs to the class of foods which do not become an integral part of the living cells, or "tissue proteids," as does much of the albumen, salts, etc., but remain in the plasma which bathes the cells, are oxydised there, and constitute their pabulum, the materials which supply the active elements with much of their energy, the "circulating proteids," carbohydrates, etc. Thus it happens that alcohol can for a time sustain life when no food (so-called) is taken, as in confirmed drunkards, and in some cases of severe illness. Professor Binz, of Bonn, who has studied this question with great industry and success, has calculated how much energy is contained in a gramme of alcohol, and finds that two ounces of absolute alcohol yield about the same amount of warmth to the body as is supplied by an ounce and a half of cod-liver oil. The *uses* of alcohol as a food will be presently described along with its other applications.

(2) *Alcohol as a nutritive depressant.*—Whilst it is itself thus oxydised in the tissues, alcohol unquestionably interferes with the metabolism or oxydation of other substances, especially (it would appear) saving or sparing the wear and tear of the "tissue-proteids," or formed protoplasm of the cells. This has been determined from three facts observed in animals

supplied with alcohol; first, that less oxygen is absorbed; secondly, that the temperature falls, and the albuminous tissues, whilst they do not waste, tend to degenerate into fat, so that the body as a whole grows fat and gross; thirdly, and chiefly, that the amount of urea, uric acid, carbonic acid, and salts excreted, is decidedly diminished. These are settled facts; the explanation of them is more difficult. The interference of alcohol with the oxygenating function of the red corpuscle is one obvious cause of impaired metabolism; another is the extreme readiness of the alcohol when it reaches the tissues to seize upon the oxygen which is there, thus robbing as it were the fixed elements of their necessary share, and arresting their decomposition at the middle stage of fat. This remarkable property of alcohol of **saving tissue waste** is one of the foundations of its employment in fever, to be presently discussed.

(3) *Alcohol as a stimulant and narcotic.*—The *circulation* in every part of the body is stimulated by a moderate dose of alcohol. The rise in the force and frequency of the heart, and the dilatation of the peripheral blood-vessels, which together constitute this **increased circulatory activity,** are both so far reflex effects from the mucous membrane of the stomach, as we have already seen; but they are also in part direct, the alcohol exciting the nervo-muscular structures of the heart, the cardiac centre, possibly the vaso-dilator centres in the medulla and cord, and certainly the nervo-muscular tissue of the middle coat of the vessels. To these causes of circulatory excitement must be added the voluntary muscular movements which are much exaggerated under the influence of alcohol. When alcohol is taken in large quantities, its stimulant effect passes into depression, both reflex and direct, and death may result, in part at least from cardiac failure.

Upon the *nervous system*, the first effect of alcohol in moderate quantity is one of stimulation. The **nervous centres are increased in vigour** from the highest to the lowest, and in the same order of sequence. The imagination becomes brilliant, the feelings are exalted, the intellect is cleared, the will is strengthened, the senses become more acute, the feeling of bodily strength and ability is raised, and some of the appetites are temporarily excited. The centres of speech, and of muscular movements generally, are specially exalted, giving rise to animated talk and lively gesticulations; and, therewith, a sense of *bien être*, referable to the combined nervous and circulatory excitement, spreads over the system.

If the dose of alcohol be larger, these phenomena of stimulation are more pronounced, but very soon give place to

depression, which spreads, like the excitement, from the highest to the lowest centres of the brain and cord. The intellectual, emotional, and voluntary faculties become first inco-ordinated, then dull, and finally completely arrested; the muscles are first **ataxic** and next paralysed, so that after an unsteady, staggering gait, the erect posture is impossible; and the consequent depression of the respiratory and circulatory centres leads to stertorous breathing, circulatory failure, and even death. The effects of alcohol upon the nervous centres are referable partly to dilatation of the blood-vessels of the brain and cord, but certainly also to a direct action of the drug upon the nerve cells.

The action of alcohol on the other bodily functions is chiefly, if not entirely, indirect. Thus, the *muscles* are affected solely through the nervous centres and nerves. *Respiration* is first increased, then slowed and weakened, partly through the special centre, but manifestly also, to a great extent, through the muscles and the circulation. Death occurs partly by asphyxia. The **bodily temperature is, on the whole, lowered** by alcohol: (1) by increased circulation through the dilated peripheral vessels; (2) by increased perspiration; (3) by diminished metabolism; and (4) after large non-medicinal doses, by general depression. The sense of warmth is, on the contrary, increased by the flushing of the skin with blood, a condition which promotes bodily heat and comfort in a warm or moderately cool atmosphere, but causes rapid refrigeration, general vital depression, and even death, in low states of the external temperature.

4. SPECIFIC USES.

The uses to which the complex specific action of alcohol may be turned are many, and of great importance:

Alcohol is employed in **fever,** and other acute wasting diseases, such as delirium tremens, and acute mania. The indications in these conditions are to prevent or to make good the great waste of tissues associated with the disease; to sustain the heart and nervous system, which threaten to fail, as the frequent pulse and the delirium testify; and to promote the loss of heat, which is formed in excess, as indicated by the thermometer, the dry-brown tongue, the sleeplessness, and the general restlessness of the patient. We have seen that these ends are all fulfilled to a certain extent by alcohol. When the symptoms just mentioned appear, brandy or other form of spirit, and wines of the stronger varieties, are given in a definite amount per diem, according to the height of the fever, the state of the pulse and heart sounds, the general strength, the ability to consume food, the previous habits, and the age of the patient. It must be distinctly understood, however, that alcohol is by no means essential in every case of fever; the very opposite being the case. In delirium tremens (acute alcoholism), where food, in the ordinary sense of the word, can often be given only with the greatest difficulty, the very substance which, as a stimulant, has caused the disease, must be judiciously continued as a form of nourishment for a time.

In chronic diseases attended by great debility, want of appetite, and possibly sickness, such as pulmonary phthisis, alcohol will also find its place as a true food.

As a **stimulant** the principal use of alcohol is in connection with the heart. This, as we have just seen, is an important part of its action in fever. Of all remedies in threatening death by cardiac failure (syncope, fainting), spirits are the best, being at once available, convenient, rapid in their action, and almost invariably successful, if recovery be possible. For this purpose, brandy, whisky, etc., should be given either pure or only slightly diluted, by the stomach, bowel, or even under the skin. Hardly less valuable is alcohol, given continuously in small regular doses, in chronic disease of the heart, when natural hypertrophy fails and dilatation ensues. Wine, rectified spirit, or various tinctures, may be given in such cases.

In *nervous* depression alcohol must be ordered with the greatest hesitation. In melancholia, or in despondency begotten by grief, anxiety, suspense, over-work, excess, and especially by indulgence in alcohol itself, this drug affords only too ready relief, as also in neuralgia, hysteria, and allied disorders and sleeplessness; and the recommendation of it by the practitioner is frequently abused, being employed as a pretext for continued intemperance. In such cases the best rule is to order a definite amount of some weak alcoholic drink, such as ale or claret, at meal times only; but even this recommendation is by no means always safe. Severe pain, such as neuralgia, is often successfully relieved on the same principle. Some forms of sleeplessness are readily overcome by warm alcoholic draughts at bed-time, or malt liquors; but here again great discrimination is requisite in ordering the remedy.

5. REMOTE LOCAL ACTION AND USES.

Alcohol given in medicinal doses is, as we have seen, almost entirely oxydised in the system, only 16 per cent. passing out unchanged, chiefly by the lungs, less by the kidneys, and least by the skin. This amount, however, includes ethereal and other complex bodies associated with alcohol in wines and spirits; and by far the greater part of the alcohol proper is excreted as carbonic acid and water.

The **diuretic** effects of spirits, wines, and especially gin and beer, are well known, and may sometimes be employed in medicine. The **diaphoretic** effect of alcohol and its applications have been already sufficiently discussed under fever.

Circumstances modifying the action and employment of alcohol.—The different alcoholic fluids act very differently, according to their strength; their other constituents, already enumerated; the presence of carbonic acid in them (sparkling drinks), which increases the rapidity of their action on the stomach and possibly of their absorption; the degree to which they are diluted with water; and the condition of the stomach as regards the presence of food. The age of the patient, the soundness of his kidneys and other eliminating organs, his habits as regards alcohol, and the amount of exercise which he can take, must also be carefully estimated in ordering the remedy. In conditions of waste and exhaustion, especially febrile states and after operations, large quantities (even 1 pint of brandy per diem) may sometimes be tolerated.

ALCOHOL AMYLICUM. AMYLIC ALCOHOL.

"Fousel Oil," $C_5H_{12}O$, with a small proportion of other spirituous substances.

Source.—Contained in the crude spirit produced by the fermentation of saccharine solutions with yeast, and separated in the rectification of such spirit.

Characters.—A colourless oily liquid, with a penetrating and oppressive odour, and burning taste; specific gravity, ·818. Boils at 270°. Sparingly soluble in water; freely in spirit and ether.

Impurities.—Other æthereal substances; detected by specific gravity and boiling point.

Preparation.

Sodæ Valerianas.—See *Valerianæ Radix*, page 272.

USE.

Amylic alcohol is used only to prepare Valerianate of Soda.

CHLOROFORMUM. CHLOROFORM. $CHCl_3$.

Terchloride of Formyl.

Source.—Made by (1 and 2) distilling Rectified Spirit with Chlorinated Lime and Slaked Lime (oxydising and chlorinating the alcohol); washing with Sulphuric Acid; and redistilling with Slaked Lime and Calcium Chloride. (1) $2C_2H_6O + O_2 + Cl_{12} = 2C_2HCl_3O$ (chloral) $+ 6HCl + 2H_2O$. (2) $2C_2HCl_3O + Ca2HO = 2CHCl_3 + Ca2CHO_2$ (formate of lime).

Characters.—A limpid, colourless, heavy, volatile liquid, of an agreeable ethereal odour and sweet taste. Solubility, 10 in 7 of spirit; 1 in 200 of water; freely in olive oil and turpentine. Sp. gr., 1·49.

Impurities.—Hydrocarbons; detected by green colour with sulphuric acid. Non-volatile compounds; detected by residue and unpleasant odour after evaporation. Alcohol; detected by opalescence when dropped into water.

Dose.—3 to 10 min.

Preparations.

1. **Aqua Chloroformi.**—1 in 200 of Water. *Dose,* ½ to 2 fl.oz.

2. **Linimentum Chloroformi.**—1, with 1 of Camphor Liniment.

3. **Spiritus Chloroformi.**—"Chloric Ether." 1 to 19 of spirit. *Dose,* 10 to 60 min.

4. **Tinctura Chloroformi Composita.**—2; Spirit, 8; Compound Tincture of Cardamoms, 10. *Dose,* 20 to 60 min.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally applied, and allowed to evaporate, chloroform causes a sense of coldness, and depresses the terminations of the sensory nerves of the part, thus reducing sensibility or removing pain. If, on the contrary, the vapour be confined, or the chloroform rubbed into the skin, it acts as an irritant, causing redness and even vesication, with a sense of heat and pain, followed by anæsthesia of the part. A similar effect is produced on all exposed mucous membranes. As a **local anæsthetic,** chloroform may be applied on lint, covered closely with a wine-glass (*e.g.* in temporal headache); or in the form of liniment with various combinations of belladonna and other anodynes, which are used for the relief of lumbago, neuralgia, etc. The student must understand, however, that the local anodyne effect of chloroform bears a very inferior relation to its rapid and powerful action as a general anæsthetic.

Internally.—When it is given by the mouth, chloroform produces an intensely hot, sweet taste, which renders it useful in pharmacy to cover the nauseous, bitter, and astringent characters of many drugs. It may also be used to relieve toothache. Like alcohol, it causes reflex salivation, and in this way, as well as by a **carminative** action on the stomach, the compound tincture, spirit, and aqua are useful adjuvants to stomachic and tonic mixtures, relieving pain, vomiting, and flatulency. In full doses it may give rise to vomiting, as is frequently seen after anæsthesia. A few drops of chloroform inhaled from a sponge or piece of lint (quite apart from its action and use as a general anæsthetic), rapidly soothe the respiratory nerves, and may be employed to arrest spasm of the glottis, asthma, and spasmodic or dry useless cough attending irritation of the air passages.

2. ACTION IN THE BLOOD.

Chloroform enters the circulation by the respiratory organs, stomach, and the unbroken skin, as well as subcutaneously. Chiefly as chloroform, partly as various products, it mixes with the blood; but its action on the living circulating blood is still obscure.

3. SPECIFIC ACTION AND USES.

Chloroform reaches the tissues very rapidly, especially if administered in the form of vapour freely mixed with air, as it always is when given as a **general anæsthetic.** Its most important action is exerted upon the central nervous system, and demands detailed description. The phenomena which it produces will first be noted; secondly, an analysis will be made of these; thirdly, the uses of chloroform will be enumerated; and fourthly, the method of administering the anæsthetic, and certain necessary precautions will be briefly indicated.

1. **Phenomena of chloroform anæsthesia.**—*a. First stage.* The first effect of the inhalation of chloroform on the nervous system is powerful **stimulation,** but almost from the commencement this is accompanied by a certain amount of disorder. The first few inspirations seem to rouse the cerebrum to increased activity, an effect due to the direct action of the anæsthetic on the nerve-cells of the convolutions and partly, perhaps, to vascular disturbance. The highest centres are first and chiefly excited so that the imagination and feelings immediately become exalted, always, however, with some confusion. For a moment the senses may be quickened, but they are quickly disordered and depressed: vision, hearing, and touch become dulled or blurred, and a strange feeling of lightness, freedom, tingling, or numbness pervades the surface and the extremities. All these sensations are strictly central, probably convolutional in origin.

At the same moment, or almost immediately after, the chloroform rouses the spinal or muscular centres, and various gesticulations and spasmodic or struggling movements may ensue.

The medulla oblongata is next affected, the centres of circulation and respiration being stimulated, so that the pulse and respiration become more frequent (although the latter is more shallow), the face flushed, the blood pressure raised. At this point the skin becomes moist, a red rash in irregular patches may appear on the neck and chest; and the pupils may dilate slightly.

These phenomena vary greatly in different instances, with the constitution and condition of the nerve-centres, the temperament and habits of the individual, laughing or crying or noisy struggling being the most prominent feature in many cases.

b. Second stage.—The second effect of chloroform on the nerve-centres is **depression.** The same parts continue to be affected by the drug, but their functions, instead of being increased or simply disordered, are first diminished, and at last completely arrested. Consciousness now ceases, with the appearance of heavy sleep. Perception and sensation are annulled: the patient sees nothing, hears nothing, feels no pain. For the same reason, reflex excitability is first diminished and then lost: irritation of any part by tickling or pinching no longer induces movements of the limbs; at last, even touching the cornea causes no reflex rolling of the eye-ball or winking of the lids.

As the anæsthesia deepens, the reflex and automatic excitability of the cord and medulla is also diminished, and the phenomena that ensue affect all the parts supplied by these centres. The muscular tone is lost, and the voluntary muscles become paralysed and relaxed. The pupil is semi-contracted, and may dilate on stimulation of afferent nerves. The heart and respiratory organs are no longer excited, but their centres in the medulla being now depressed, their action is laboured, the pulse falling in frequency (a striking change from the previous acceleration) and in strength, and the respiratory movements being slow, heavy, and attended by noise or stertor.

Now is the time for the surgeon to operate, anæsthesia being complete, whilst the depression of the vital functions is still within safe limits. The effects may be expected to pass off in a few minutes if the administration be stopped; and although the amount required to complete the second stage varies greatly with the subject and other circumstances, it may be said that from 1 to 4 fluid drachms will probably have been given up to this point.

c. Third stage.—Beyond the second stage or degree, chloroform anæsthesia is highly dangerous, the further action of the drug being attended by complete **loss of all reflex excitability** of the cord and medulla. The sphincters relax, the pupils are widely dilated and fixed, the globes prominent. The respiratory centre is no longer irritable, and the movements of the chest become weaker, irregular, sighing, and finally cease. The cardiac centre fails, the heart beating irregularly and feebly, and at last stopping in diastole, both from central and from direct nervo-muscular depression. The blood-vessels dilate, the pressure falls to zero, and the circulation has come to a standstill. It is obvious that the direct effects of chloroform on the respiratory centre are complicated towards the last by venosity of the blood. Death may occur through the heart, the respiration, or both together.

2. **Analysis of the phenomena of chloroform anæsthesia.**—Chloroform anæsthesia affords us an excellent opportunity of studying the action of a drug upon the various centres of the nervous system, from the highest downwards. The first parts to be stimulated are the cerebral centres with mental functions, the control of the special senses and consciousness; and these are the first to be depressed and finally annulled. The lower cerebral and spinal centres are affected less and somewhat later, so that a certain degree of excitement of these accompanies the first cerebral depression; and the spinal centres being no longer controlled by the cerebral, irregular excessive movements of the limbs ensue. As the depression deepens in the spinal centres, the muscles are paralysed. Lastly, the lowest centres of all, those of organic life, connected with the heart, vessels, respiratory organs, and sphincters, situated in the medulla and cord, yield to the action of chloroform. Although affected from the first, it is not until the higher parts have become completely overpowered that the functions of these vital centres are seriously impaired, and death threatens. It is on account of the safe order of invasion of the different centres by chloroform that it has been selected as the proper agent for temporarily arresting consciousness; we shall find that many other powerful drugs equally depress the nervous system, but in a direction exactly the reverse.

The peripheral nerves are affected last of all in general anæsthesia, and it must be repeated that the loss of sensibility to the knife is due to a *central*, not a peripheral effect.

The muscles are finally affected directly, as well as through the nervous system. The pupil is dilated in the first stage, probably by stimulation of the sympathetic; and contracted in the second, and dilated in the third stage, by stimulation and paralysis respectively of the third nerve or its cerebral centre. The other involuntary muscles are less obviously paralysed, and the parturient uterus contracts freely in complete anæsthesia, with some loss, however, of vigour and regularity.

3. **Specific uses of chloroform.**—The circumstances under which chloroform anæsthesia may be employed are the following: (1) In *operations attended by pain.* These need not be particularised. (2) In *operations where muscular action or spasm has to be overcome:* reduction of herniæ, dislocations and fractures; catheterism. (3) In *diagnostic manipulations:* exploration of the abdomen externally and *per rectum.* (4) In *diseases attended by excessive pain*, especially biliary and renal calculus. (5) In *parturition*, in certain subjects and conditions, the degree of anæsthesia induced being generally slight until the moment of birth. (6) In *spasmodic diseases*, such as tetanus, hydrophobia, uræmia, puerperal convulsions, the *status epilepticus*, severe chorea, and hiccup.

4. **Method of administration, and principal precautions to be observed in chloroform anæsthesia.**—This is a purely practical subject, to be learned by experience and not in theory. The student has frequent opportunities of witnessing the administration of anæsthetics by skilled persons, and he must closely and carefully observe every effect of the chloroform upon the patient. He will do well to interpret every phenomenon as it arises, such as mental and muscular excitement, the character of the breathing, the colour of the countenance, and (if possible) the state of the pulse, into exact physiological terms, as explained above; as, for example, stimulation of the convolutions and cord, interference with the respiratory centre, etc. He will thus come to appreciate accurately the condition of the patient at any moment, and be prepared to assist in administering anæsthetics himself. Many purely practical points will then have to be learned: the selection of suitable cases for anæsthesia; the preparation of the patient; the choice of the anæsthetic and of an inhaler; the position of the patient; the method of watching the face, eyes, pulse and respiration; the detection of unfavourable symptoms, and their immediate treatment; and, finally, the after treatment of the case. All these and other matters connected with the administration of anæsthetics can be but briefly referred to in the following paragraphs:

a. Selection of cases.—Chloroform must be given with great caution to the aged and infirm, to persons who are subject to attacks of faintness, or known to suffer from fatty degeneration or dilatation of the heart, to very fat and very anæmic persons, to epileptics, to chronic drunkards, to the subjects of extensive disease of the lungs or respiratory passages. Nitrous oxide gas or ether must be preferred in such subjects, according to the length of the operation. Valvular disease of the heart with compensation suggests special care, but is not a contra-indication. Operations on the mouth, nose, throat, attended by possible bleeding into the glottis, demand special precautions, whether by great expedition, special postures of the patient, or even previous tracheotomy. It must never be forgotten, however, that when an operation is absolutely necessary, it can always be more safely performed with anæsthetics than without their aid; and that before the days of ether and chloroform, many persons died under an operation, from fear, faintness, and shock, the danger from which is completely removed or greatly diminished by anæsthetics.

b. Preparation of the patient.—Insensibility is more rapid when the stomach is empty. No solid food should therefore be given for at least six hours before the operation, which should, if possible, be performed early in the morning when digestion has been completed and the anæsthetic is rapidly absorbed. If the patient feel faint under these circumstances, a small quantity of brandy and water may be given before operation. Artificial teeth must be removed. The respiration and pulse should be carefully noted before commencing inhalation.

c. Selection of the anæsthetic: purity of the same.—The anæsthetic agents in general use at the present time are chloroform, bichloride of methylene, ether, and nitrous oxide gas. Of these, ether and nitrous oxide are unquestionably to be preferred, unless there be some special reason to the contrary. The purity of the drug is best insured by purchasing it from well-established makers, and not by attempting to test it for oneself; and the same manufacture should always be used, if possible. It may be advisable to commence with one anæsthetic, and then, as circumstances alter during the operation, to change it for another.

d. Selection of the apparatus.—This will depend on circumstances and on the taste and experience of the administrator. Whilst elaborate inhalers are used in hospitals, it is satisfactory to know that the simplest apparatus is equally safe, such as a handkerchief or towel made into a cone, care being taken that chloroform vapour is mixed very freely with air, but that with ether, on the contrary, the atmosphere is excluded as completely as possible. A few capsules of nitrite of amyl and a straight polypus forceps should be ready at hand.

e. Position of the patient.—The administrator must accommodate himself to the convenience of the operator, whose eye and hand must never be interfered with. If possible, the patient's head should be placed in such a position on the edge of a pillow that the saliva may flow from the mouth instead of into the stomach, and that the tongue may not fall back and produce dyspnœa. It is essential that the patient's chest and abdomen should not be compressed in the slightest degree by clothes or by the arms of the assistants, or confined by bandages. The most comfortable position for the patient is on the side, with one hand and fore-arm beneath the pillow; and as a rule it is better to induce insensibility in this position, and afterwards arrange the patient for the surgeon, than to ænasthetise him in the constrained attitude often required in operations.

f. Administration.—The confidence of the patient should first be gained by a few minutes' conversation, whilst he is reassured as to the result and instructed how to breathe. When inhalation has commenced, the administrator must not even for a single instant cease to watch the face, respiration, and pulse. The degree of insensibility necessary for different cases varies greatly, the least being required for uterine, the most for rectal operations. The loss of the corneal reflex, and stertorous breathing, are generally employed as tests of insensibility, but no single sign can be relied upon. The smallest possible quantity of the drug should always be given; and patients once thoroughly anæsthetised by ether may be kept under its influence for many minutes by rebreathing the air of expiration loaded with its vapour mixed with some fresh air.

g. Complications and unfavourable symptoms.—*Vomiting* is generally preceded by pallor of the face or a few deep inspirations. When it occurs, care must be taken that nothing is drawn into the larynx; the head should therefore be thrown forward, and the mouth opened by pressure on the symphysis of the jaw, or by inserting a pair of forceps between the teeth. Should vomited matter be inhaled into the respiratory passages and asphyxia threaten, laryngotomy must be immediately performed.

Lividity of the face and prolonged deep *stertor* should be checked by raising the shoulders so that the diaphragm may descend more easily, and by making the patient breathe fresh air. The position of the head is to be changed until respiration is more easy; the vessels of the head and neck must be allowed to empty themselves well and quickly; and the mouth may have to be opened to its fullest extent, which induces a deep inspiration, the following expiratory effort often clearing the larynx and fauces of tenacious mucus which had been obstructing the entrance of air.

Pallor of the face is to be combated by lowering the head and shoulders; if severe, by dropping the head over the end of the table. If this should not succeed, the vapour of nitrite of amyl should be given.

Shallow breathing, especially if intermittent, should be anxiously watched; and if it increase, artificial respiration should be at once resorted to, on no account waiting for the respiration to cease.

h. After-treatment.—Absolute quiet and keeping the eyes closed often prevent sickness after an operation. The whole surface of the body being carefully covered to prevent chill, the room should be cleared of ether vapour as quickly as possible. Cough induced by ether is often attended by blood-stained mucus, which, with these precautions, is of no consequence. Food should not be given within two hours after the operation, and for the first twelve hours should be entirely cold, and consist chiefly of soups and jellies, milk being avoided. A teaspoonful of burned brandy will often relieve the after-sickness, when all other measures have failed.

4. REMOTE LOCAL ACTION.

Chloroform is excreted in part, as such, by the kidneys, lungs, and skin; part is lost in the system. No use is made of its remote effects, although small doses given by the mouth are said to increase all the secretions.

ÆTHER. ETHER. $C_4H_{10}O$.

A volatile liquid prepared from Alcohol, and containing at least 92 per cent. pure ether. $C_4H_{10}O$.

Source.—Made by (1 and 2) distilling Rectified Spirit with Sulphuric Acid, purifying with Slaked Lime and Chloride of Calcium, and redistilling. (1) $C_2H_6O + H_2SO_4 = C_2H_6SO_4$ (sulphovinic acid) $+ H_2O$. (2) $C_2H_6SO_4 + C_2H_6O = C_4H_{10}O + H_2SO_4$.

Characters.—A colourless, very volatile liquid, with peculiar strong odour and hot taste. It is entirely dissipated in vapour when exposed to the air, boils below 105° Fahr., and is very inflammable. It contains 8 per cent. of spirit. Specific gravity, 0·735.

Impurities.—Alcohol; tested by specific gravity.

Dose.—20 to 60 min.

Preparations.

1. **Æther Purus.**—Pure Ether. Ether free from alcohol and water.

Source.—Made by shaking ether with water, separating, purifying by quicklime and chloride of calcium, and distilling.

Characters.—Specific gravity, 0·720. Boils at 96° Fahr. Given by inhalation.

Impurities.—Alcohol and water; detected by specific gravity.

2. **Spiritus Ætheris.**—Ether, 1; Rectified Spirit, 2. Specific gravity, 0·809. *Dose,* 30 to 60 min.

From Spiritus Ætheris is prepared:

Tinctura Lobeliæ Ætherea. See *Lobelia.*

Ether is also used in making Collodion and Liquor Epispasticus; and in many pharmaceutical processes.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—When allowed to evaporate, ether is a powerful **refrigerant** and **anæsthetic,** abstracting heat and depressing the nerves of the part. It is used in the form of Dr. Richardson's spray to relieve the internal local pain of neuralgia, and more frequently to prevent pain in minor surgical operations, the parts being completely frozen in the course of a few minutes by the spray of pure ether from a proper apparatus. If the vapour be confined, or the ether rubbed into the skin, a **rubefacient** or even **vesicant** effect is produced, as with chloroform. The Ethereal Extract of Mezereon and Liquor Epispasticus are powerful vesicants and **counter-irritants.**

Internally.—Ether has a powerfully burning, disagreeable taste, and causes local irritation and reflex **salivation** in the mouth, like chloroform. Reaching the stomach, it acts as a local **stimulant** to the blood-vessels, nerves, and muscular coat, and is therefore used as a **carminative,** relieving pain and sickness, and expelling flatulence, especially in nervous subjects. At the same time, it acts reflexly from the gastric mucosa upon the heart and respiratory organs, as a powerful **systemic stimulant.** It is a very useful ingredient of powerful **anti-spasmodic** draughts, as will be presently described. Given with cod-liver oil, it renders it more palatable to some patients, and more digestible, possibly by stimulating the pancreas.

2. ACTION ON THE BLOOD.

Ether is absorbed into the blood with remarkable rapidity, and acts here like chloroform.

3. SPECIFIC ACTION AND USES.

The specific action of ether and its employment as an **anæsthetic** so closely agree with those of chloroform that the reader is referred to the description of the latter drug, and the differences between the two substances only require to be mentioned here. These are:

1. Ether must be administered nearly pure, say 70 per cent. of the vapour with 30 per cent. of air; whilst but 3 to 4 per cent. of chloroform is given, with 97 or 96 per cent. of air.

2. With ether the stage of stimulation is more protracted; there is more struggling; and the stage of anæsthesia is shorter and the degree less profound. Ether is therefore said to be safer than chloroform.

3. Ether depresses the heart and vessels less than chloroform, the heart continuing to beat after respiration has been arrested by an excessive dose. The respiratory centre is also less depressed. For these reasons, also, ether is called a safe anæsthetic.

4. Ether has a much less pleasant smell than chloroform.

In choosing between ether and chloroform, preference must be given to the **safer anæsthetic**, and the use of ether has accordingly been much revived during the last few years. Under certain circumstances chloroform is preferable, as in operations about the mouth, ether causing a profuse secretion of ropy mucus; in operations where a light or the cautery might come into contact with the ether vapour and cause an explosion; in operations which must be hastily undertaken and completed; and in parturition, where profound anæsthesia is unnecessary. Infants bear chloroform well, and their delicate respiratory passages are less irritated by it than by the pungent vapour of ether.

Given by the stomach in small doses, ether increases the activity of the circulation and nervous system—partly, as we have seen, by reflex action from the gastric wall; and is used as a powerful and rapidly diffusible stimulant and antispasmodic. It is given largely in cardiac failure, faints, angina pectoris, palpitation, and depression, being even more rapid in its effects than alcohol, but more evanescent, and of course less available in emergencies. Its antispasmodic powers make it useful in hysterical and epileptic threatenings; and in spasmodic cough and asthma it is one of the most valuable remedies during the seizure.

4. REMOTE LOCAL ACTION AND USES.

Ether is excreted like chloroform, and to a certain extent increases all the secretions, but is not employed with this end in view. It is believed by some to diminish the liability to gall stones, or actually to dissolve concretions already formed.

NITROUS OXIDE. N_2O. (*Not Officinal.*)

Nitrous Oxide Gas, Protoxide of Nitrogen, "Laughing Gas."

Source.—Made by heating Nitrate of Ammonia. $NH_4NO_3 = N_2O + 2H_2O$.

Characters.—A colourless inodorous gas. It is provided for use condensed into a liquid, in strong iron bottles, whence it is allowed to escape into a caoutchouc bag.

ACTION AND USES.

1. ACTION ON THE BLOOD AND ITS USES.

Nitrous oxide gas, administered from an inhaler, rapidly enters the circulation; is absorbed by the plasma; converts the arterial into venous blood, in the course of about sixty seconds; and thus **produces partial asphyxia.** It does so apparently by diminishing the amount of oxygen in combination with the red corpuscles, without itself uniting with the hæmoglobin, like CO and NO; in this respect it is an "indifferent" gas, like N and H, simply taking the place of the oxygen, if this be completely excluded at the same time, and exerting of itself no poisonous action upon the corpuscles. It must, therefore, be given pure, *i.e.* without any admixture of air. The effect of the incipient asphyxia, and the use to which it may be turned, will be described in the next section.

2. SPECIFIC ACTION AND USES.

Nitrous oxide gas not only renders the blood venous, but simultaneously enters the nervous centres, upon which it acts, first as a stimulant, and speedily as an **anæsthetic.** Thus the gas produces a series of phenomena which can be resolved into the parallel effects of venosity of the blood or asphyxia, and a specific influence on the nerve cells of the convolutions. After a few seconds' excitement, the subject for anæsthesia by nitrous oxide begins to breathe laboriously; the mind becomes rapidly obscured; and by the end of about sixty seconds consciousness is lost, the face may be livid and bloated in appearance, respiration becomes stertorous, muscular twitchings occur, the pulse fails at the wrist, and the whole appearance is alarming to a novice. If the inhalation be now interrupted, perfect recovery of consciousness and of natural breathing occurs in thirty to sixty seconds, with disappearance of all the urgent symptoms. It is clear that asphyxia is carried into the second stage—that of respiratory excitement, but not beyond, neither the movements of the chest nor the action of the heart being arrested. But even if these untoward results should occur, resuscitation is easy by means of artificial respiration; it is said even after five minutes in the case of rabbits. No attempt to carry the asphyxia beyond the second stage is permissible in man.

Nitrous oxide gas is extensively used to produce anæsthesia during operations lasting but one minute or less, and especially by dental surgeons during the extraction of teeth, destruction of the nerve, etc. It must always be given pure, by the arrangement above described in the hands of a skilled anæsthetist. The moment for operating is best indicated by stertorous breathing and twitching of the muscles. Persons with diseased vessels, such as the subjects of chronic Bright's disease, ought not to take this anæsthetic, which produces (like all asphyxiating agents) a great and sudden rise of the arterial pressure, likely to cause rupture within the brain.

DICHLORIDE OF ETHIDENE. (*Not Officinal.*)

Source.—Obtained in the manufacture of chloral.

Characters.—A colourless volatile liquid, with the odour and taste of chloroform. Specific gravity, 1·20. Readily soluble in ether, chloroform, and alcohol; with difficulty in water.

ACTION AND USES.

Dichloride of ethidene is a **general anæsthetic**, supposed to occupy a position somewhat between ether and chloroform, but depressing the heart more than the latter. It is a very safe anæsthetic in some animals, but, like all its allies, occasionally causes death in man. About 4 fl.dr. in the form of vapour are required for an adult.

ÆTHYL BROMIDUM. Bromide of Ethyl. Hydrobromic Ether. C_2H_5Br. (*Not Officinal.*)

Source.—Made by adding Bromine to a mixture of Phosphorus and Absolute Alcohol, and distilling. $5C_2H_6O + PBr_5$ (bromide of phosphorus) $= 5C_2H_5Br + H_3PO_4 + H_2O$.

Characters.—A colourless liquid with a powerful fragrant odour, and a hot sweetish taste. Very volatile; specific gravity, 1·42. Non-inflammable. Readily decomposes, yielding bromine. Freely soluble in alcohol and ether; very sparingly soluble in water.

Dose.—10 to 60 min.

ACTION AND USES.

Bromide of ethyl acts as an **anæsthetic** like chloroform and ether. For a time it was used in America and England, especially in short painful operations, and in ophthalmic practice, as its action is rapid and evanescent, and sickness rare. More than one death during or after its administration must account for its sudden loss of popularity. It has also been given by the stomach as an antispasmodic, especially in convulsions.

BICHLORIDE OF METHYLENE. CHLORIDE OF MONO-CHLOR-METHYL. $CH_2Cl_2(CH_2Cl.Cl)$.

(*Not Officinal.*)

Source.—Obtained from Chloroform by the action of nascent Hydrogen, one atom of which replaces one atom of chlorine in the Chloride of Dichlor-methyl (chloroform), $CHCl_2.Cl$.

Characters.—A colourless volatile liquid, with an odour like chloroform. Specific gravity, 1·344. Soluble in water, ether, and alcohol.

ACTION AND USES.

Bichloride of methylene acts as a **general anæsthetic** very much like chloroform. It is said, however, to depress the heart even more than this substance; and it is now very seldom used for general surgery, but is the anæsthetic most frequently employed in ovariotomy.

ETHYLATE OF SODIUM, SOLUTION OF.

(*Not Officinal.*)

Source.—Made by dissolving metallic Sodium in Absolute Alcohol.

Characters.—A brownish syrupy liquid.

ACTION AND USES.

Sodium ethylate is a powerful **caustic**, used to destroy small accessible tumours, such as nævi.

SPIRITUS ÆTHERIS NITROSI. SPIRIT OF NITROUS ETHER.

"Sweet Spirit of Nitre." A spiritous solution, containing nitrous ether, ethyl nitrite, $C_2H_5NO_2$.

Source.—Made by distilling a mixture of Rectified Spirit, Nitric Acid, Sulphuric Acid, and Copper; and dissolving the Distillate in Spirit. $C_2H_6O + HNO_3 + H_2SO_4 + Cu = C_2H_5NO_2 + CuSO_4 + 2H_2O$. The equation represents the formation of ethyl nitrite, but the drug also contains acetic ether, aldehyde, and acetic acid dissolved in spirit.

Characters.—Transparent and nearly colourless, with a slight tinge of yellow, mobile, of an apple-like odour, and a sweetish cooling sharp taste; slightly acid; inflammable. Sp. gr., ·845.

Incompatibles.—Iodide of potassium, sulphate of iron, tincture of guaiacum, gallic and tannic acids. Emulsions are curdled by its addition.

Impurity.—Excess of acid; effervescing much with $NaHCO_3$.

Dose.—½ to 2 fl.dr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

In the stomach spirit of nitrous ether is a **diffusible stimulant** and carminative, doubtless from the amount of alcohol which it contains.

2. ACTION ON THE BLOOD.

The nitrite of ethyl appears to produce the same effect on the red corpuscles as other nitrites, especially diminishing oxygenation. *See* AMYL NITRIS.

3. SPECIFIC ACTION AND USES.

Although anæsthetic to a degree, sweet spirit of nitre chiefly acts upon the circulation like amyl nitrite. It relaxes the peripheral vessels, and accelerates the heart, but much less quickly, less completely, and more persistently than the amyl compounds. Thus it **lowers arterial tension,** and causes the phenomena described at page 163, only in a much less degree. By relaxing the renal vessels it is diuretic, the water alone being increased; by dilating the cutaneous vessels, as well as by perspiration, it increases the loss of heat from the skin. Nitrous ether is chiefly used as an **antipyretic** in febrile affections, where it diminishes the heat production by acting on the blood, and increases the loss of heat through the skin and kidneys. As a **diuretic** it is useful when a free watery flow is desired to wash out the tubules and passages, and relax spasm in the renal vessels, as in some cases of Bright's disease with increased arterial tension. Probably for the same reason it fails as a diuretic in cardiac dropsy, where the veins demand relief, and the arterial pressure is already too low. Being a dilator of the renal vessels, it must not be used in acute inflammatory states of the kidney. Spirit of nitrous ether may also relieve angina pectoris, and cardiac pain dependent on a failing and dilating heart in chronic Bright's disease. Like other nitrites, it has benefited some cases of dysmenorrhœa and of asthma.

4. REMOTE LOCAL ACTION.

This compound or its constituents are chiefly excreted by the kidneys and lungs. Its diuretic influence has just been described.

ÆTHER ACETICUS. Acetic Ether.

$C_2H_5.C_2H_3O_2.$

Source.—Made by (1) distilling Rectified Spirit with Acetate of Soda and Sulphuric Acid; and (2) separating the ethereal liquid by means of Chloride of Calcium. (1) $NaC_2H_3O_2 + H_2SO_4 + C_2H_6O = C_2H_5,C_2H_3O_2 + NaHSO_4 + H_2O.$

Characters.—A colourless liquid, with an agreeable ethereal, somewhat acetous odour, and refreshing taste. Specific gravity, 0·91. Neutral. Soluble freely in rectified spirit and ether, and in about 12 parts of water.

Dose.—20 to 60 min.

ACTION AND USES.

Acetic ether is a **stimulant** and **antispasmodic**, much like ether itself, but forms more agreeable combinations with other **carminatives** on account of its pleasant odour and taste.

CHLORAL HYDRAS. Hydrate of Chloral.

$C_2HCl_3O.H_2O.$

Source.—Made from Chloral by the addition of Water. Chloral (C_2HCl_3O) is itself made by the action of dried Chlorine upon anhydrous Alcohol, and purifying. $C_2H_6O + Cl_8 = C_2HCl_3O + 5HCl.$

Characters. — Colourless crystals, or white crystalline masses, with a peculiar pungent odour, and a pungent, rather bitter taste. Readily fused by gentle heat, recrystallising on cooling to 120°. Solubility, very freely in distilled water, rectified spirit, and ether; 1 in 4 of chloroform.

Incompatibles.—All alkalies.

Impurities.—Hydrochloric acid, detected by test-paper; oily substances, colouring sulphuric acid when dissolved in chloroform.

Dose.—5 to 30 gr.

Preparation.

Syrupus Chloral.—10 gr. in 1 fl.dr. *Dose*, $\frac{1}{2}$ to 2 fl. dr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Applied in weak solution (5 gr. to the ounce of water), chloral hydrate is antiseptic; concentrated solutions are irritant, causing vesication. The drug is but little used externally.

Internally.—In the mouth and stomach it is also irritant unless freely diluted, a point to be observed. It has no specially sedative effect on the stomach or bowels like opium, and therefore causes neither dyspepsia nor constipation.

2. ACTION ON THE BLOOD.

Chloral enters the blood as such, and probably leaves it for the tissues without decomposition, although Liebreich, who introduced it into the materia medica, contends that it is broken up into chloroform and formic acid in the presence of the sodium salts of the plasma. $C_2HCl_3O + NaHO = NaCHO_2 + CHCl_3$. The blood undergoes no appreciable change.

3. SPECIFIC ACTION AND USES.

The action of chloral upon the system so nearly resembles that of chloroform, and the chemical relations of the two substances are so close, that Liebreich's theory is at first sight extremely plausible. Chloral chiefly affects the nervous system, although one of the principal dangers connected with its use depends on its direct action on the heart. Given in moderate doses (20 to 30 gr.), hydrate of chloral, after a very brief period of excitement, quickly induces drowsiness, followed by several hours' sound sleep, natural in its characters and refreshing in its effect; as a rule, without consequent confusion, headache, or drowsiness in healthy individuals. Larger doses produce deeper and more prolonged sleep, and an appearance of narcosis, the subject being difficult to rouse even by sharp stimulation. Thus far chloral manifestly acts upon the convolutions, either directly or through the cerebral circulation, or both; and is a **pure and powerful hypnotic.** The larger doses, however, enable us to appreciate its action, like that of chloroform, on the lower nervous centres. The spinal centres are depressed, whence diminished reflex excitability and relaxation of the muscles. The three great medullary centres are decidedly depressed: respiration becomes slow, irregular, and shallow; the heart is weakened (but chiefly in another manner, as we shall presently find); and the vaso-motor centre is lowered in activity, so that the vessels dilate generally. The peripheral sensory nerves are not specially affected. Neither are the motor nerves, or the muscles themselves, directly depressed.

Upon these several effects of chloral depend at once its value medicinally, and the drawbacks or even dangers which occasionally attend its employment. It is the most rapid, and probably the most powerful, whilst the most pure, of all the hypnotics, opium not excepted. It is therefore extensively used to produce sleep and soothe the cerebral hemispheres, in conditions of excitement, in insomnia from over-work, distress, maniacal excitement, or despondency, and in the early stages of fevers or febrile diseases, whilst the heart is still strong. It is especially valuable in delirium tremens. In the sleeplessness which attends or is caused by peripheral pain, chloral fails, for an obvious reason; or if sleep be secured by a powerful dose, the patient wakes to suffering as before. To relieve the severe pain of neuralgia it is totally unfitted.

Chloral has also been given in the delirium of the more advanced stages of fevers; to relieve the distress, dyspnœa, and insomnia of cardiac and renal disease; and in the cough, spasm, and breathlessness attending phthisis, bronchitis, and other respiratory affections. The dangers of the drug in these conditions have been shown by the fatal results which have followed its employment; and the cause of them is obvious. Besides its depressing effect on the medulla, chloral in full doses acts as an intrinsic cardiac poison, slowing and enfeebling the heart by diminishing the irritability of its ganglia, and finally arresting it in ventricular diastole. At the same time the blood pressure falls by peripheral paralysis of the vessel walls, as well as from the interference with the vaso-motor centre, the heart, and the respiration; so that altogether the circulation tends to become arrested. Thus the relief to be obtained from chloral in the delirium of fever where the heart is threatening to fail, and in organic disease of the heart, lungs, or kidneys, is but temporary, and is purchased at serious cost; for this purpose the drug is not to be recommended.

The action of chloral in reducing the excitability of the grey matter of the cord, and higher motor ganglia, has suggested its use in tetanus, strychnia poisoning, puerperal convulsions, hydrophobia, sea-sickness, and whooping-cough. It has also been given in some cases of chorea, but here really as a hypnotic.

The exact effect of chloral on metabolism is unknown. It reduces temperature, chiefly by increased loss of heat from the dilated peripheral vessels, but also by diminishing the production in the weakened muscles, etc. It must not, however, be given as an antipyretic in high fever, unless at the commencement, in strong subjects, on account of its depressant action on the heart. It has been highly recommended in cholera.

4. REMOTE LOCAL ACTION.

Chloral is excreted by the kidneys partly unchanged, but chiefly as urochloralic acid producing slight diuresis. Probably part escapes by the skin also, as a variety of eruptions may attend its prolonged use.

5. ADVANTAGES AND DISADVANTAGES OF CHLORAL; CAUTIONS; CONTRA-INDICATIONS.

It will be well to state here succinctly the advantages and disadvantages of chloral as compared with morphia (opium). Chloral has the following *advantages:* It acts quickly as a hypnotic—even more quickly than morphia subcutaneously, and more certainly even when morphia has failed. After-effects, such as headache, depression, and sickness are less common from chloral. It does not derange the stomach, if freely diluted; nor cause constipation, even when given for a long time. It may be more safely given, in proper doses, to children.

On the other hand, chloral has these *disadvantages:* It does not relieve pain, and is thus greatly inferior to opium in most cases as a hypnotic, and useless as an anodyne. It does not, like opium, prevent or relieve distress, reflex dyspnœa, and cough due to heart and lung disease. Chloral causes excitement instead of quiet, in many cases of mania, hysteria, and confirmed alcoholism.

Chloral must be given in relatively small doses to children and delicate persons; and very rarely, as we have seen, to the subjects of organic disease of the heart, lungs, and kidneys, or patients suffering from gout. If it excite instead of soothing the insane or the confirmed drunkard, it should not be persevered with; nor if it increases instead of relieving sleeplessness in certain individuals, as it does occasionally, apparently from idiosyncrasy. Lastly, chloral must be prescribed with great hesitation to persons who suffer from constitutional debility of the nervous system, expressing itself in hysteria, despondency, excitability, and innumerable other forms. Such subjects very readily acquire the "chloral habit," that is, they consume on their own account regular and ever increasing quantities of chloral, until the nervous system and general nutrition fail, the mind is demoralised, and the victims ultimately perish like the drunkard and opium eater.

BUTYL-CHLORAL HYDRAS. HYDRATE OF BUTYL-CHLORAL. CROTON-CHLORAL. $C_4H_5Cl_3O$.

(*Not Officinal.*)

Source.—Made by passing Chlorine gas through Acetic Aldehyde, which is converted first into Crotonic Aldehyde, and then into Croton Chloral.

Characters.—Small brilliant tabular crystals, with a pungent odour, much like that of chloral hydrate, and an acrid nauseous taste. Solubility, 1 in 100 of water, freely in spirit, 1 in 4 of glycerine.

Incompatibles.—As of chloral hydrate.

Dose.—2 to 15 gr.

ACTION AND USES.

In every important respect the action of butyl-chloral is nearly allied to that of chloral hydrate, and it will therefore suffice to indicate the points wherein the two drugs differ.

Butyl-chloral as a **hypnotic** is less rapid, less certain, and less powerful than the other, which is generally to be preferred for this purpose. It is believed that butyl-chloral is less depressant to the heart, and therefore that it may be given in insomnia with cardiac weakness where chloral hydrate would be inadmissible. We must accept this recommendation with great caution. The most important effect of butyl-chloral, peculiar to itself, is **anæsthesia** of the region of the trigeminus, that is, of the face and part of the scalp, preceding the hypnotism. But even this action has been disputed by good authorities. The drug relieves some cases of *tic-douloureux* and facial neuralgia very quickly; in some cases it fails. It has been given in other forms of pain in the face, such as toothache (locally); in neuralgia of the limbs; and in painful menstruation.

AMYL NITRIS. NITRITE OF AMYL. $C_5H_{11}.NO_2$.

Source.—Produced by heating Nitric Acid with Amylic Alcohol, distilling, and purifying the product.

Characters.—An ethereal liquid, of a yellowish colour, and peculiar pine-apple odour. Sp. gr., ·877. Insoluble in water; soluble in rectified spirit, ether, and chloroform.

Impurities.—Nitric and hydrocyanic acids.

Dose.—2 to 5 min., used with caution as inhalation from a crushed capsule; or ½ to 1 min. internally, dissolved in rectified spirit.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Applied *directly* to peripheral nerves and muscles, nitrite of amyl depresses or paralyses them. It is never so employed in man. *Internally,* the drug is seldom given by the mouth, except in cholera.

2. ACTION ON THE BLOOD.

Nitrite of amyl is almost invariably administered by inhalation, a few drops being kept ready for use in a glass capsule (enveloped in cotton wool), which may be broken between the fingers and thumb when required. The vapour instantly enters the circulation through the lungs, converts a certain amount of hæmoglobin into methæmoglobin, and thus interferes with the oxygenating function of the red corpuscles; the amount of oxygen absorbed (in animals) being quickly lowered, as well as the excretion of carbonic acid. The blood of animals killed by nitrite of amyl is of a chocolate colour; but the effect of an ordinary inhalation in man is very transitory.

3. SPECIFIC ACTION AND USES.

Nitrite of amyl almost instantaneously reaches the tissues, and produces striking phenomena. Two to five drops, inhaled as directed, immediately produce a sense of fulness and throbbing in the head; flushing of the face, neck, and trunk; tingling over the surface generally; dilatation of the pupils, and disturbance of vision; giddiness and unsteady gait;

increased frequency and force, that is, palpitation, of the heart; visible pulsation of the carotids; restlessness and anxiety of mind. These symptoms quickly disappear, leaving possibly slight headache. Larger doses aggravate all the phenomena, but never produce unconsciousness; mental confusion, intense bodily depression, coldness of the extremities, and sweats being the result, followed by severe headache which may last for hours. Very rarely convulsions occur in man as in some of the lower animals.

The specific action of nitrite of amyl proves on analysis to be almost confined to the circulatory system, the other parts being chiefly involved secondarily. Two distinct effects are produced on the circulation; the **heart is** greatly **accelerated,** with but little, if any, increase of its force; the peripheral **vessels are dilated** by relaxation of their muscular coat. Some authorities hold that the cardiac acceleration is due to depression of the cardiac centre, others to depression of the vagus in the heart; some refer the vascular relaxation to the action of the nitrite on the vasor centre in the medulla, others to its action on the vaso-motor nerves and muscular walls. Be this as it may, the fact remains that the **blood pressure falls** to a remarkable degree, that is, the resistance to the discharge of the left ventricle is correspondingly diminished; whilst this discharge is accomplished much more frequently within a given time. In other words, the left ventricle, under the influence of nitrite of amyl, has at once less work to accomplish, and more force wherewith to accomplish it; that is, is greatly relieved. These considerations led Dr. Lauder Brunton to the employment of the drug in those cases of the complex class of disease known as angina pectoris, in which agonising pain in the breast and neighbourhood is due to distension of the left ventricle, from its inability to empty itself against the pressure in the aorta, and in which fatal paralysis of the heart, or even rupture of its walls, is the result of the unequal effort. Clinical experience has fully confirmed the value of amyl nitrite, in cases where spasm of the arteries is damming the blood back upon the ventricle, the channels being instantly opened and the ventricle rapidly emptied by the double effect of the drug. The pain of the aneurism of the aorta, and of other forms of cardiac disease and disorder, can often be relieved by amyl, but caution must be exercised in the first trial. Threatening death from cardiac paralysis in chloroform anæsthesia, and sea-sickness in which the blood pressure is greatly disturbed, are sometimes successfully treated with amyl. Some cases of epilepsy, accompanied by spasm of the cerebral vessels and facial pallor, and of megrim or sick-headache, due to similar spasm in the trigeminal area, are also benefited by this drug.

The reflex irritability of the cord is reduced (in animals) by nitrite of amyl, which has therefore been proposed as a remedy in poisoning by strychnia. Neither the peripheral nerves nor the muscles are affected when it is given through the blood. Respiration is disturbed, apparently by the alteration of the hæmoglobin and circulation, not through the nervous system. The nitrite sometimes affords immediate relief in asthma, but the dyspnœa may as quickly return. The body temperature falls, from obvious causes.

4. REMOTE LOCAL ACTION.

Nitrite of amyl probably escapes from the body by the urine, which is decidedly increased in amount, and may contain sugar. Both of these effects are probably results of local disturbance of the pressure in the kidneys and liver respectively.

NITRO-GLYCERINUM. NITROGLYCERINE.

$C_3H_5N_3O_9$. (*Not Officinal.*)

Source.—Made by dropping Glycerine into a mixture of Sulphuric and Nitric Acids, washing, and evaporating to a proper density.

Characters.—An oily liquid, colourless, odourless, with a sweet pungent taste. Specific gravity, 1·60. Slightly soluble in water; freely in fats, oil, alcohol, and ether. Highly explosive, and, when mixed with infusorial earth, constitutes dynamite. Never used in the pure state.

Preparation.

Liquor Nitroglycerine.—1 gr. in 100 min. of rectified spirit. *Dose*, ½ to 2 min.; in water, or as a chocolate tablet.

ACTION AND USES.

This powerful substance closely **resembles in its action the nitrites of amyl and soda**; its activity being apparently due to nitrous acid formed by its decomposition within the body. It is used for the same class of cases, such as angina pectoris, chronic heart disease, sea-sickness, and asthma and other spasmodic disorders.

ÆTHYL IODIDUM. Iodide of Ethyl. Hydriodic Ether. C_2H_5I. (*Not Officinal.*)

Source.—Made by adding iodine to a mixture of Alcohol and Phosphorus, distilling, and purifying. $5C_2H_5HO + PI_5$ (iodide of phosphorus) $= 5C_2H_5I + H_3PO_4 + H_2O$.

Characters.—A colourless volatile liquid, with a peculiar powerful odour, and a pungent taste. Sp. gr., 1·92. Non-inflammable. Decomposed by light, yielding iodine. Soluble in alcohol and ether; very sparingly soluble in water.

Dose.—5 to 20 min. Inhaled from a broken capsule.

ACTION AND USES.

Iodide of ethyl acts chiefly by virtue of the iodine element, and very slightly, if at all, as an anæsthetic ethyl compound. It introduces iodine very rapidly into the system, and has been chiefly used to stimulate the respiratory passages, and thus to act as an **antispasmodic** in asthma attended by scanty or tough secretion. In some instances it gives instant relief.

ACIDUM HYDROCYANICUM DILUTUM.

Diluted Hydrocyanic Acid.

"Prussic Acid." Hydrocyanic acid, HCN, dissolved in water, and constituting 2 per cent. by weight of the solution.

Source.—Made by distilling solutions of Ferrocyanide of Potassium and Sulphuric Acid. $2K_4Fe(CN)_6 + 6H_2SO_4 = 6HCN + Fe_2K_2(CN)_6 + 6KHSO_4$.

Characters.—A colourless liquid, with a peculiar penetrating odour. Sp. gr., 0·997. Faintly acid.

Incompatibles.—Salts of silver, copper, iron, red oxide of mercury, and sulphides.

Impurities.—Sulphuric and hydrochloric acids.

Dose.—2 to 8 min.

Preparation.

Vapor Acidi Hydrocyanici.—10 min. in 1 fl.dr. cold water.

Hydrocyanic acid is also contained in Aqua Laurocerasi. See also *Amygdala Amara*, page 239.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Applied for a time to the skin, dilute hydrocyanic acid causes numbness, directly **depressing the sensory nerves.** It is used, largely diluted, to relieve itching, but must not be employed where the surface is raw from scratching, as it is readily absorbed by wounds.

Internally, it produces a peculiar mixed sensation on the mouth and throat, and acts as a **sedative** to the nerves of the stomach. It is in common use to relieve pain and arrest vomiting in painful dyspepsia, ulcer of the stomach, cardialgia, and reflex or other nervous cases, *e.g.* in phthisis and pregnancy. The specific action of the drug on the medulla, to be presently described, doubtless assists its local effect upon the gastric nerves in producing these results.

2. ACTION ON THE BLOOD.

Hydrocyanic acid enters the blood very rapidly from all parts, especially the lungs, and produces an important change on the red corpuscles. If freely given, it converts the blood of the veins first into a bright arterial colour, and then into a deep black, the former change arresting the oxygenating function of the corpuscles, the latter destroying them. When studied in drawn blood, these effects are found to be due partly to *reduction* of the oxyhæmoglobin, the oxygen being replaced by cyanogen, forming cyano-hæmoglobin; and partly to *union* of the cyanogen with oxyhæmoglobin, making cyano-oxyhæmoglobin. Thus changed, blood does not give up oxygen to oxydisable bodies, *e.g.* the guaiacum reaction cannot be obtained. These effects of hydrocyanic acid on drawn blood must not be too readily applied to the circulating fluid within the body, where its action in medicinal doses is chiefly local and specific.

3. SPECIFIC ACTION AND USES.

Hydrocyanic acid rapidly enters the tissues, and acts chiefly upon the nervous structures. Considerable doses cause giddiness, faintness, nausea, a constricted feeling in the chest, headache, mental confusion, disturbed breathing, slowing of the pulse, and muscular debility. Larger doses aggravate these symptoms, and produce great dyspnœa and other signs of asphyxia; whilst in still larger quantity it is familiar as one of the most swift and deadly of poisons. Analysis proves that this drug, whilst **depressing all nervous tissues,** acts first and chiefly upon the *respiratory centre*, which is briefly excited and then depressed, leading to weak respirations with long pauses, dyspnœa, convulsions, and finally death by asphyxia. Simultaneously, the afferent branches of the *respiratory nerves* are depressed, especially if the acid be inhaled; and reflex respiratory acts are arrested. The *vaso-motor centre* is temporarily stimulated, and the blood pressure rises, but it falls again suddenly and greatly. The *cardiac centre* is the most resistant of the three, but it also is depressed, so that the action of the heart becomes less frequent and powerful. Although at the same time the nervo-muscular structures of the heart are depressed, the heart continues to beat in animals poisoned with prussic acid, after the respiration and other functions have ceased. The *convolutions* are depressed, causing stupor, ending in unconsciousness; but this effect may be secondary to the disturbance of respiration. The cord is also lowered in activity. The peripheral *sensory nerves* are but little affected by the internal use of the drug, compared with its effect upon them locally. The *motor nerves* and *muscles* are depressed by repeated small doses of dilute hydrocyanic acid, the influence extending downwards.

The chief specific use of this drug is to allay dry, useless cough, by its action on the respiratory centre and the afferent nerves, in phthisis, pertussis, and asthma. In phthisis it also checks the tendency to cough and vomit induced by food. As a cardiac sedative, it is employed in the palpitation, pain, and distress brought on by dyspepsia, where again it fulfils a double indication. Its general sedative effect on the nervous system has suggested its use in epilepsy, chorea, hysteria, and tetanus, but with very doubtful benefit.

4. REMOTE LOCAL ACTION.

The mode of excretion of hydrocyanic acid is still obscure. Probably it escapes in part, as it enters in part, by the lungs; and some of it is supposed to be thrown out as formate of ammonia.

TRIMETHYLAMIN. PROPYLAMIN. (*Not Officinal.*)

An ammonia compound, in which the thre atoms of hydrogen are replaced by methyl, $NC_3H_9 = N(CH_3)_3$, dissolved in water.

Source.—Obtained from herring brine by distillation. It is also contained in cod-liver oil and in various plants.

Characters.—Trimethylamin contains 10 to 20 per cent. of the ammonia compound; is colourless, with a very disagreeable smell and taste; alkaline; miscible with water. Propylamin is another name for impure trimethylamin.

Dose.—20 to 60 min.

ACTION AND USES.

Externally, trimethylamin is a local irritant. *Internally*, it **lowers the frequency of the heart, the blood-pressure, and the temperature.** It was for a time believed to be specially valuable in acute rheumatism, but is now very seldom used.

ACIDUM CARBOLICUM. CARBOLIC ACID, PHENIC ACID, PHENOL, PHENYLIC ALCOHOL.

C_6H_5HO.

An acid obtained from coal-tar oil by fractional distillation and purification.

Characters. — Colourless, acicular crystals; hygroscopic; with a tarry odour and burning taste. Becomes and remains fluid on addition of 6 per cent. of water. Solubility, 1 in 15 of water, 1 in $1\frac{3}{4}$ olive oil, $3\frac{1}{2}$ in 1 of glycerine. It does not redden blue litmus paper.

Dose.—1 to 3 gr.

Preparations.

1. **Glycerinum Acidi Carbolici.**—1 to 4.
2. **Suppositoria Acidi Carbolici cum Sapone.**—1 gr. in each.

Sodæ Sulphocarbolas.—Sulphocarbolate of Soda. $NaC_5H_6SO_4H_2O$. (*Not Officinal.*)

Source.—Sulphocarbolic acid is formed by direct union of Carbolic and Sulphuric Acids. The Sulphocarbolate of Soda by neutralising Sulphocarbolic acid with Carbonate of Soda.

Characters.—Whitish odourless lumps of minute colourless rhombic prisms. Soluble in water.

Dose.—20 to 60 gr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—The principal action and uses of carbolic acid in disease depend upon its influence on fermentation and decomposition, which are intimately associated with many pathological processes. When this influence is studied apart from the body, we find that most *organised ferments* (fungi, bacteria, infusoria) are readily deprived of their characteristic powers by solutions of carbolic acid; whilst *chemical ferments*, such as pepsin and ptyalin, are much less readily affected. At the same time the products of decomposition, which are almost invariably foul-smelling, are *deodorised* by the phenol. The exact *modus operandi* in all these cases is still unknown, as are also the nature of the processes, and the relation of organisms to them. Be the explanation what it may, the power of carbolic acid, or of any substance which can thus arrest molecular processes universally at work in physiology and pathology, must be said to be enormous, both in itself and in its effects.

Carbolic acid is extensively employed in the **antiseptic** method of the treatment of wounds, associated with the name of its introducer, Sir Joseph Lister. A 5 per cent. solution in water serves as a spray to cleanse instruments, and to wash the skin of the part before operation. A 2½ per cent. watery solution is used to purify sponges and the hands of the operator, and as a lotion. Dissolved in olive oil (1 to 10, 1 to 20, 1 to 50, or still weaker), or 1 part of carbolic acid with 7 parts of castor oil and 8 of almond oil, it is used for lubricating catheters, or as a special dressing. Carbolic acid gauze consists of unbleached cotton gauze medicated with half its weight of a mixture of carbolic acid (1), resin (4), and paraffin (4).

Coming to its physiological action proper on the human tissues, we find that carbolic acid is a local irritant to the skin, causing burning pain, anæsthesia, and finally a caustic effect with formation of a white hard eschar. It may therefore be applied to poisoned wounds and foul ulcers; and in dilute solutions is a **stimulating** as well as a **disinfecting** wash to wounds and discharging mucous surfaces or cavities, in the form of a lotion, injection, or gargle. It also relieves some forms of itching and inflammatory skin diseases, and is used with success in ringworm, where it destroys the vegetable organisms.

Apart from the body, carbolic acid is extensively used as **a general disinfectant.**

Internally.—In the form of vapour, carbolic acid is stimulant and disinfectant, and is used in ulceration of the throat and lungs (phthisis, dilated bronchi, gangrene, etc.), much importance having lately been attached to it in the so-called "antiseptic" treatment of phthisis. In the stomach and bowels it is a powerful irritant poison in large doses; in moderate quantity it arrests fermentative changes in the gastric contents in cases of dilatation of the viscus. Two other points may be noted in this connection; first, that carbolic acid unites with sulphates to form sulphocarbolates, which suggests the use of soluble sulphates as antidotes in poisoning by the drug; and secondly, that phenol is a natural product of the intestine or its contents.

2. ACTION ON THE BLOOD.

Carbolic acid is rapidly absorbed from the unbroken skin, mucosæ, wounds, subcutaneous tissues, respiratory passages, and stomach; and for a considerable time can be found in the blood unchanged. Here it steadily disappears, by conversion into compounds from which it may be again derived; uniting, for example, with sulphates, as already described. The blood is dark and slow to coagulate after poisoning by the drug.

3. SPECIFIC ACTION AND USES.

The action of carbolic acid on the organs is of little interest to the therapeutist. It is found in them chiefly as phenol-yielding compounds; and its effects in man are chiefly those of an irritant poison. The heart first falls and then rises in frequency, from disturbance of the cardiac centre. The blood pressure rises at first, returns to the normal, and falls after a fatal dose. Dyspnœa ensues, also central in origin. Convulsions occur in the lower animals through the cord, then paralysis and collapse. The voluntary muscles are not affected by carbolic acid, but the pupil is contracted. Sensibility is not reduced by internal administration of the drug. The temperature falls slightly after medicinal doses, but may rise in cases of dangerous absorption from dressings. Carbolic acid has been given internally in fevers, it is said with good results, but is little used in this country for such a purpose. It may temporarily relieve diabetes.

4. REMOTE LOCAL ACTION.

Carbolic acid and its products rapidly leave the body, chiefly by the urine. But little of it can be recovered unchanged, for (1) part is lost in the system, being probably converted into oxalates and carbonates; (2) part appears as sulphocarbolic acid ($C_6H_5.H.SO_4$) in combination; (3) part is constituted by an obscure compound; and (4) the remainder appears to give rise to a peculiar olive-green, brown, or grey discoloration of the urine, which is familiar to surgeons. It is important to note that this change in the urine bears no definite relation to the amount of carbolic acid in the blood, or the danger of poisoning. Fainting and collapse are the principal symptoms of its excessive absorption from a wound or through the skin, with or without rise of temperature. Disappearance of the sulphates from the urine, easily ascertained by ordinary tests, is a sure indication of danger. Albuminuria is sometimes induced.

Carbolic acid also leaves the body by the saliva, which is increased, and it stimulates the flow of sweat although it is not found in it.

Resorcin. (*Not Officinal.*)—A derivative of carbolic acid by various processes.

Characters.—White tabular lustrous crystals, with a weak odour like carbolic acid, and a sweetish, somewhat pungent taste. Solubility, 1 in 2 of water; 1 in 20 of olive oil.

Dose.—5 to 30 gr. every two hours, or single doses of 60 gr. at long intervals.

ACTION AND USES.

Externally.—Resorcin is **antiseptic** and **disinfectant**, without being irritant, in ordinary solutions (2 to 10 per cent.) It has been used as a dressing for all kinds of sores and wounds.

Internally.—It passes rapidly through the system, and is excreted unchanged in the urine by the end of one hour. It causes diaphoresis, and **reduces the temperature and pulse** for a time in conditions of fever; but has no influence on the normal body heat. Excessive doses cause trembling, singing in the ears, deafness, and mental disturbance. It has been used as an **antipyretic** in fevers of every kind, and is said to be specially useful in ague; but the drug is still on its trial.

Chinolin. C_9H_7N. (*Not Officinal.*)—A derivate of Cinchona Bark, whence its name. Now made synthetically, or by the action of glycerin on nitro-benzol and aniline, in the presence of a dehydrating agent.

Characters. — A colourless, oily-like, highly refracting liquid, with a peculiar odour. It forms salts with acids, of which the tartrate is used, occurring in lustrous crystals, soluble in water.

Dose.—Of chinolin, 3 to 10 min.; of the tartrate, 5 to 15 gr.

ACTION AND USES.

Chinolin is **antiseptic** and **disinfectant** externally. *Internally*, it is an **antipyretic**, like resorcin, and has been used for the same class of cases.

Kairin. (*Not Officinal.*)—A pale-buff powder, with a disagreeable bitter and somewhat aromatic taste. It is made from phenol.

Dose.—5 gr. every hour; or 15 to 20 gr. in single doses.

ACTION AND USES.

Kairin is **antiseptic, disinfectant,** and especially **antipyretic,** like the two preceding substances, to which it is closely allied.

Fuchsine—MAGENTA DYE. (*Not Officinal.*)—An aniline product occurring in brilliant beetle-coloured needles, forming an intense deep-red solution with water.

Dose.—½ to 4 gr.

ACTION AND USES.

Fuchsine passes through the blood and tissues, and colours the urine and fæces. It has been said to reduce the amount of albumen in some cases of Bright's disease.

Creasotum—CREASOTE.—A product of the distillation of Wood Tar.

Characters.—A liquid, colourless or with a yellowish tinge, a strong empyreumatic odour, and burning taste. Soluble, sparingly in water; freely in alcohol, ether, and glacial acetic acid. Sp. gr., 1·071. Coagulates albumen.

Impurity.—Carbolic acid; detected by becoming solidified by cooling.

Dose.—1 to 3 drops, with mucilage or bread crumb.

Composition.—Creasote is not a simple body, but a variable compound of *Guaiacol*, $C_7H_8O_2$, and *Kreasol*, $C_8H_{10}O_2$.

Preparations.

1. **Mistura Creasoti.**—Creasote, 16 min.; glacial acetic acid, 16 min.; spirit of juniper, 30 min.; syrup, 1 fl.oz.; water, 15 fl.oz. *Dose,* 1 to 2 fl.oz.
2. **Unguentum Creasoti.**—1 in 9.
3. **Vapor Creasoti.**—12 min. in 8 fl.oz. of boiling water.

ACTION AND USES.

The action of creasote is, practically speaking, the same as that of carbolic acid, to which the student is referred. Before the latter came into general use, creasote was not unfrequently employed for the same purposes internally to which carbolic acid is now put; but the uncertainty of its composition and strength, as a complex product, renders it inferior to phenol in this respect.

The Unguentum is employed in dry skin diseases. The Vapor is **disinfectant** and deodorant in phthisis, chronic bronchitis, gangrene, and other diseases of the lungs attended by foul discharges. A combination of creasote, iodine, and various volatile substances such as ether, chloroform, and spirit, has lately become popular as a constant inhalation in phthisis. The Mistura Creasoti is intended chiefly as a remedy in vomiting, especially when this is due to pyloric obstruction, dilatation of the stomach, and the development of fermentation; but it has also been recommended in the vomiting of pregnancy, hysteria, and sea-sickness.

A specific and remote local effect has lately been claimed for creasote, when given by the stomach, namely, as a disinfectant and deodorant in phthisis with antipyretic and healing properties.

IODOFORMUM. IODOFORM. CHI_3. (*Not Officinal.*)

Source.—Made by the action of Iodine on a hot solution of Carbonate of Soda in Diluted Alcohol. $C_2H_6O + 8I + 3Na_2CO_3 = CHI_3 + NaCHO_2 + 5NaI + 2H_2O + 3CO_2$.

Characters.—Small lemon-coloured lustrous crystals, with a powerful and persistent saffron-like odour, and an unpleasant sweetish taste. Insoluble in water; soluble freely in fixed and volatile oils and ether. It contains more than 90 per cent. of iodine.

Dose.—½ to 3 gr. or more.

Preparations.

Unguentum Iodoformi (U.S.P.).—1 to 9 of benzoated lard.
Iodoformum Præcipitatum.—An impalpable yellow powder.
Iodoform Wool.—Absorbent Cotton Wool, containing 10 per cent. of iodoform.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Iodoform is an **antiseptic** and **disinfectant**, but destroys organisms less readily than carbolic acid. It is a very powerful deodorant. Applied to the human tissues, it produces little or no irritation.

Iodoform is used to cleanse foul ulcers, especially of venereal origin; and may possibly have a special effect on strumous ulceration. It has also been extensively applied as an antiseptic dressing to healing wounds, the best forms being the wool and the ointment. Sometimes iodoform gauze has been employed. Iodoform bougies for insertion into the urethra and os uteri have not given satisfaction. A powder of iodoform diluted with quinine or bismuth is a valuable insufflation in ozœna and ulcers of the mouth and throat.

2. ACTION ON THE BLOOD, SPECIFIC, AND REMOTE LOCAL ACTION AND USES.

Iodoform is occasionally absorbed from wounds, causing sickness and fever, restlessness and delirium in some subjects, drowsiness and collapse in others. Iodine is possibly set free in the blood, appearing in the urine as iodide of sodium. Iodoform has been used in an endless variety of diseases internally, but unfortunately with no special benefit.

Petrolatum (U.S.P.) — PETROLEUM OINTMENT, VASELINE. (*Not Officinal.*)

Source.—Obtained from American petroleum by distilling off the lighter portions and purifying the residue.

Characters.—A yellowish semi-solid fat-like mass, transparent, odourless, tasteless, neutral. Insoluble in water; freely soluble in fixed and volatile oils.

ACTION AND USES.

Vaseline cannot become rancid or irritant to the skin, and, being readily miscible with many active substances, such as the phenol compounds and alkaloids, is indicated as a valuable **basis for ointments** instead of lard. Its chief disadvantage is the low point at which it melts, and its consequent tendency to spread through the dressings. It is now extensively used.

Part II.

THE ORGANIC MATERIA MEDICA.

GROUP I.

THE VEGETABLE KINGDOM.

RANUNCULACEÆ.

Aconiti Folia—Aconite Leaves.—The fresh leaves and flowering tops of Aconitum Napellus. Gathered when about one-third of the flowers are expanded, from plants cultivated in Britain.

Characters.—Leaves smooth, palmate, divided into five deeply cut wedge-shaped segments; exciting slowly, when chewed, a sensation of tingling. Flowers numerous, irregular, deep blue, in dense racemes.

Aconiti Radix—Aconite Root.—The dried root of Aconitum Napellus. Imported from Germany, or cultivated in Britain. Collected in the winter or early spring before the leaves have appeared.

Characters.—Usually from one to three inches long, not thicker than the finger at the crown, tapering, blackish-brown, internally whitish. A minute portion, cautiously chewed, causes prolonged tingling and numbness.

Substance resembling Aconite Root: Armoracea. (*See* page 202.)

Composition.—The active constituent of aconite is *aconitia* or *aconitin*, $C_{30}H_{47}NO_7$, an amorphous or crystalline alkaloid, forming salts with acids. The names of *pseud-aconitin*, *napellin*, *nepallin*, *napalin*, *aconellin*, etc., have been given to other more or less identical active principles obtained from the same plant or its botanical allies. They are combined with a peculiar acid, *aconitic acid.*

Preparations.

A. *Of the Leaves:*

1. Extractum Aconiti.—A green extract. *Dose*, 1 to 2 gr.

B. *Of the Root :*

1. **Tinctura Aconiti.**—1 in 8 of spirit. *Dose*, 5 to 10 min.
2. **Linimentum Aconiti.**—1, in 1 of spirit, with $\frac{1}{20}$ camphor.
3. **Aconitia.**—An alkaloid obtained from aconite root. Made (1) by dissolving the alcoholic extract of the powdered root in water; (2) Precipitating the impure aconitia by ammonia; (3) Extracting the dried precipitate with ether, dissolving in diluted sulphuric acid, again precipitating with ammonia, and purifying.

Characters.—See *Composition.* Not given internally.

Preparation.

Unguentum Aconitiæ.—1 in 60.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Applied to the skin, or an exposed mucous membrane, aconite affects the terminations of the sensory nerves, causing tingling, followed by numbness, and **lowering** the **sensibility** of touch and temperature. It is, therefore, used to relieve pain due to disorder of the peripheral nerves, especially certain forms of neuralgia, and acute and chronic rheumatism. The aconitia ointment must be employed with caution.

Internally.—Aconite and aconitia cause an intensely acrid sensation on the tongue, followed by persistent tingling and numbness. A sense of warmth, pain, and sickness follow its admission to the stomach in full doses.

2. ACTION ON THE BLOOD.

Aconitia enters the blood, and thence finds its way to the tissues.

3. SPECIFIC ACTION AND USES.

Medicinal doses of aconite, taken in close succession, **reduce** the frequency, force, and tension of the **pulse**; **flush** and **moisten** the **skin**; and **increase** the amount of **urine.** Larger doses cause a sense of illness and muscular weakness; "creeping," "tingling," "numb" sensations generally, but especially on the lips, face, and extremities, ending in anæsthesia; and disturbances of vision, hearing, and consciousness. On analysis, it is found that the heart is briefly accelerated, and then reduced in frequency through the nerves; its force is then reduced, by direct action on the nervo-muscular structures; and finally the cardiac action becomes more frequent, irregular, and more and more feeble, tending to cease in diastole. The blood pressure falls continuously, partly from cardiac, partly from vaso-motor depression. Respiration is slowed and deepened, with spasmodic irregularity of rhythm, and finally is arrested after poisonous quantities. The skin is stimulated, perspiration becoming abundant. The kidneys are also stimulated, the fluids and solids of the urine being increased in amount. The **temperature falls** steadily. The muscular weakness appears to be primarily due to depression of the motor-nerve endings; but this condition extends to the cord. The brain itself is not directly affected, and even in cases of poisoning by aconite, consciousness is preserved almost to the end. The sensory nerves are probably paralysed from their periphery inwards by the internal, as by the external, administration of the drug.

Such being the specific action of aconite, its use is obviously indicated in the treatment of two conditions, namely, **fever** and **pain.** The cardio-vascular excitement, the dry skin, the high temperature, and the scanty secretions of fever, will all be relieved by this drug. For this purpose the tincture is given in small and closely repeated doses, say 1 minim in water every 15, 20, or 30 minutes, the effect being watched. Acute tonsillitis, bronchitis, pleurisy, and febrile conditions attending other local inflammations, have been treated with aconite, the effect being to control the urgent symptoms, relieve the distress of the patient, and even to cut short the disease. Some of the symptoms of scarlatina and measles may be similarly alleviated. The powerfully depressant action of aconite on the circulation altogether forbids its use as an antipyretic in heart disease, and suggests caution in its employment in all cases.

In neuralgia and other painful affections connected with the nerves and muscles, aconite may be given internally instead of being locally applied; facial neuralgia with spasm (*tic-douloureux*) particularly being relieved by it. In these cases, also, the tincture should be given in minim doses, repeated three or four times in an hour, and the effect watched.

4. REMOTE LOCAL ACTION AND USES.

Aconite is probably excreted by the kidneys, and, as we have already seen, increases the activity of their secretion. The stimulation of the sweat-glands and the occasional appearance of an eruption suggest that it also leaves the body by the skin.

Podophylli Radix—PODOPHYLLUM ROOT.—The dried rhizome of Podophyllum peltatum. Imported from North America.

Characters.—In pieces of variable length, about two lines thick, mostly wrinkled longitudinally, dark reddish-brown externally, whitish within, breaking with a short fracture; accompanied with pale brown rootlets. Powder yellowish-grey, sweetish in odour, bitterish, subacrid and nauseous in taste.

Composition.—The active principle of the rhizome is the *resin*, which is really a compound of several resinous bodies.

Preparation.

1. **Podophylli Resina.**—Resin of Podophyllin.

Source.—Made by extracting with spirit, and precipitating in acidulated water.

Characters.—A pale greenish-brown, amorphous powder, soluble in rectified spirit and in ammonia.

Dose.—$\frac{1}{4}$ to 1 gr.

ACTION AND USES.

Externally, podophyllin possesses no local action; but if applied to a wound, it enters the blood and exerts its specific effect as a purgative.

Internally, podophyllin causes a bitter acrid taste, salivation, irritation of the stomach, nausea, colic, and after ten or twelve hours a free watery motion. This purgative effect appears to be due to stimulation both of the muscular coat and of the glands of the intestine, as well as to **increase of the biliary flow.**

Podophyllin is used entirely as a **purgative.** One-grain doses are given to produce free evacuation of the bowels in severe constipation or portal congestion. A dose of $\frac{1}{6}$ to $\frac{1}{4}$ grain may be employed as an ingredient of habitual laxative pills. It is a useful **cholagogue** when mercurials are contra-indicated. Podophyllin must not be given alone, on account of its griping tendency, but combined with a carminative such as hyoscyamus, belladonna, or cannabis indica. The comparative slowness of its action must also be remembered.

MAGNOLIACEÆ.

Illicium Anisatum—STAR ANISE.—The oil distilled in China from the fruit forms part of the Oil of Aniseed of the Pharmacopœia. See *Oleum Anisi.* N.O. Umbelliferæ.

Actæa Racemosa. Cimicifuga. (*Not Officinal.*) — The rhizome and rootlets of Cimicifuga racemosa (Actæa racemosa) Black Snake-root or Black Cohosh. From the United States.

Characters.—Knotted heads, with numerous fine brittle rootlets; odour faint; taste somewhat bitter, astringent, and acrid, not unlike opium.

Composition.—Cimicifuga contains a *volatile oil*, two *resins*, *tannin*. The active principle is still uncertain.

Dose.—20 to 30 gr.

ACTION AND USES.

In moderate doses black snake-root is **bitter**; in larger doses it slows the heart and raises the blood pressure like digitalis; finally it is excreted in the urine, and increases the activity of the skin, kidneys, and generative organs.

Cimicifuga is used as a **stomachic**; in diseases of the heart; and in rheumatism, bronchitis, uterine disorders and spermatorrhœa, in which its remote stimulant action is occasionally valuable. It has been much lauded in chorea.

MENISPERMACEÆ.

Calumbæ Radix—CALUMBA ROOT.—The root, cut transversely and dried, of Jateorrhiza Calumba and Miersii. From the forests of eastern Africa, between Ibo and the Zambesi.

Characters.—Slices, flat, circular, or oval, about two inches in diameter, and from two to four lines thick, softer and thinner towards the centre, greyish-yellow, bitter. A decoction, when cold, is blackened by the solution of iodine.

Composition.—Calumba contains a non-nitrogenous, bitter principle, *calumbin*, $C_{21}H_{22}O_7$, crystallising in white needles; an alkaloid, *berberin*, $C_{20}H_{17}NO_4$; *calumbic acid*, $C_{21}H_{21}O_7$; 33 per cent. of *starch;* but no tannin.

Dose.—5 to 20 gr.

Preparations.

1. **Extractum Calumbæ.**—Aqueous. 8 in 1. *Dose*, 2 to 10 gr.
2. **Infusum Calumbæ.**—1 in 20 of cold water. *Dose*, 1 to 2 fl.oz.
3. **Tinctura Calumbæ.**—1 in 8. *Dose*, $\frac{1}{2}$ to 2 fl.dr.

Calumba is also an ingredient of Mistura Ferri Aromatica.

ACTION AND USES.

Calumba is the first of the large and important group of bitter substances or **bitters**, which we meet with in the materia medica, and will therefore be fully discussed as the type of this class of remedies. Under the head of the other bitters, such as quassia and gentian, fresh description of their action and uses will be unnecessary, and reference will simply be made to the present account. So with the action and uses, *as bitters*, of the alkaloids (strychnia, quinia, etc.), and the aromatic bitters, including orange, lemon, cascarilla, etc.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Calumba and other bitters are antiseptic and disinfectant to a degree, arresting decomposition and fermentation. They are not used for this purpose.

Internally.—Taken into the mouth, bitters, as their name implies, stimulate the nerves of taste, and thus induce several general reflex effects, of the first importance in digestion. (1) The *saliva* is increased, and therewith its solvent and digestive influence on the food in the mouth, as well as its stimulant action on the gastric secretion; (2) The *vessels and glands of the stomach* are excited through the central nervous system, and the gastric secretion is thus increased in a second way; an effect which is heightened if the bitter be aromatic, and relish given by the pleasant flavour.

Reaching the stomach, calumba and other bitters stimulate digestion in a third way, by acting upon the gastric nerves and causing a sensation closely resembling hunger. This rouses the appetite, and if food be taken within a few minutes, the other effects just described afford the means of digesting it. As in the mouth, the action of bitters in the stomach is greatly assisted by aromatics (essential oils) and alcohol (contained in tinctures). Like these substances, bitters also stimulate the local circulation, and produce a remote effect on the heart and systemic vessels, raising the blood pressure, and thus acting as "general tonics." They will also exert a certain controlling effect on any decomposition or fermentation which may be set up in the stomach. When given in excess, or for a long time, bitters will manifestly, for every reason, tend to irritate the stomach and induce indigestion.

Calumba and bitters in general pass slowly along the intestines, moderating decomposition, and slightly stimulating peristalsis when they contain tannin, which many of them do. They are not cholagogue.

The *uses* of calumba and other bitters internally depend on the actions just described. They are of great value as **stomachics**, and much employed in rousing gastric digestion in atonic dyspepsia, where the appetite and the ability to digest have been diminished or lost, as in anæmia, convalescence from acute diseases, in persons exhausted by over-work, whether mental or bodily, and in the subjects of chronic constitutional diseases, such as phthisis and syphilis. In such cases, bitter infusions form the best vehicle for acid or alkaline stomachics, as the case may require, combined with an aromatic tincture, which renders the mixture much more agreeable and active. Their use must not be continued too long without intermission; they must not be given in too concentrated a form; and they must be employed with caution, or entirely avoided, in cases of dyspepsia attended by much pain, vomiting, mucous secretion, as well as in organic disease of the stomach. Calumba is one of the least irritant of all bitter stomachics.

The action of bitters on the bowels no doubt adds to their value in indigestion, as they remove flatulence and promote evacuation. Some forms of diarrhœa are relieved by calumba. Whether given by the mouth or as enema, bitter infusions are anthelmintic, preventing and destroying the thread-worm.

2. ACTION ON THE BLOOD, SPECIFIC ACTION, AND REMOTE LOCAL ACTION.

Whether bitters possess any *direct* action on the blood or tissues beyond those just described, is uncertain. The *indirect* effect on the system is manifestly great and of the first importance therapeutically, as they are the means of introducing into the blood an increased amount of nutrient material. In this way bitters are **tonics**, invigorating the body whilst they increase appetite; a system of treatment which is agreeable and striking to invalids and persons enfeebled by disease, over-work, or dyspepsia.

Pareiræ Radix—PAREIRA ROOT.—The dried root of Cissampelos Pareira. Brazil.

Characters.—Cylindrical oval or compressed pieces, entire or split longitudinally, half an inch to four inches in diameter, and four inches to four feet in length. Bark greyish-brown, longitudinally wrinkled, crossed transversely by annular elevations; interior woody, yellowish-grey, porous, with well-marked often incomplete concentric rings and medullary rays. Taste at first sweetish and aromatic, afterwards intensely bitter.

Composition.—Pareira root contains, amongst other ingredients, an active principle, *pelosin*, believed to be identical with beberia.

Incompatibles.—Persalts of iron, salts of lead, and tincture of iodine.

Preparations.

1. **Decoctum Pareiræ.**—1 in 13⅓. *Dose*, 1 to 2 fl.oz.
2. **Extractum Pareiræ.**—Aqueous. 16 in 1. *Dose*, 10 to 20 gr.
3. **Extractum Pareiræ Liquidum.**—1 in 1. *Dose*, ½ to 2 fl.dr.

ACTION AND USES.

The physiological action of Pareira is imperfectly known, but it is believed to possess mild **bitter** and **laxative** effects, and to be a moderately active **diuretic.**

Empirically, it is used in inflammatory affections of the urinary tract, from the pelvis of the kidney downwards, being held to relieve pain, reduce irritation, and promote healing and cessation of muco-purulent discharge. The extract is given along with the decoction to increase its strength; not alone.

Cocculus Indicus. (*Not Officinal.*)—The fruit of Menispermum cocculus, the Cocculus indicus plant. From the East Indies.

Characters.—A small dark brown berry containing a yellowish reniform seed.

Composition.—The active principle of cocculus is a bitter neutral substance, picrotoxine, $C_9H_{10}O_4$, in colourless crystals, neutral, soluble with difficulty in water. It is united with *menispermic* or *cocculinic acid*, and other principles.

Dose of Picrotoxin.—$\frac{1}{120}$ to $\frac{1}{20}$ gr.

ACTION AND USES.

Externally, cocculus or picrotoxin, in the form of a dilute ointment, very carefully applied to the unbroken surface, **destroys pediculi.**

Internally, picrotoxin is a very powerful agent, especially stimulating the spinal cord and medulla, and causing violent **spasms of the flexors**, and intoxication in large doses. It has been chiefly used in the **night-sweating of phthisis**, and in chronic nervous diseases.

PAPAVERACEÆ.

Papaveris Capsulæ — POPPY CAPSULES. — The nearly ripe dried capsules of the White Poppy, Papaver somniferum. Cultivated in Britain.

Characters.—Globular, two or three inches in diameter, crowned by a sessile stellate stigma.

Composition.—Poppy capsules contain a little *opium* and woody fibre; the seeds a bland oil. See *Opium.*

Preparations.

1. **Decoctum Papaveris.**—1 in 10.
2. **Extractum Papaveris.**—Aqueous. 3 in 1. *Dose*, 2 to 5 gr.
3. **Syrupus Papaveris.**—1 in nearly 2¼. *Dose*, 1 fl.dr.

ACTION AND USES.

The action of poppy capsules is the same as that of opium, but much weaker. The warm decoction is a favourite **anodyne** fomentation. The extract and syrup are uncertain remedies, and opium preparations are in every respect preferable.

Opium—OPIUM.—The juice, inspissated by spontaneous evaporation, obtained by incision from the unripe capsules of the Poppy, Papaver somniferum. Grown in Asia Minor.

Characters.—Irregular lumps, weighing from four ounces to two pounds; enveloped in the remains of poppy leaves, and generally covered with the chaffy fruits of a species of rumex; when fresh, plastic, tearing with an irregular slightly moist chestnut-brown surface, shining when rubbed smooth with the finger, having a peculiar odour and bitter taste.

Test.—This is a modification of the process for making hydrochlorate of morphia. (*See* page 186.) 100 gr. of opium ought to yield at least 6 to 8 gr. of morphia.

Varieties.—There are two varieties of officinal opium, Smyrna opium, and that of Constantinople. 1. *Smyrna, Turkey*, or *Levant* opium is the best. It occurs in irregular rounded or flattened masses, seldom more than two pounds in weight, enveloped in poppy leaves, and surrounded with the fruits or seeds of a species of rumex. Good Smyrna opium yields about 8 per cent. of morphia. 2. *Constantinople* opium is of very uncertain quality, generally inferior to Smyrna. It is found in cakes, either large and irregular, or small and lenticular, covered with a poppy leaf, and marked with its midrib, but without rumex seeds. It smells much less strongly than Smyrna opium. Besides the two officinal varieties, there are found in the market Egyptian opium, in round flattened cakes of a reddish hue, with vestiges of a leaf; Persian opium in sticks or lumps; Indian opium in balls, enveloped in poppy leaves, or in cakes; and French and English varieties.

Impurities (chiefly adulterations).—Opium is often soft from excess of water, which causes great variation in the strength. Stones, fruits, leaves, etc., may be detected by filtering a decoction; and starch by the iodine test. The officinal test is intended to ascertain the amount of morphia in specimens which are pure but of doubtful richness.

Composition.—Opium contains (1) certain *alkaloids;* (2) two *neutral substances;* (3) two organic *acids;* (4) water, resin, gum, extractives, odorous principles, and other constituents of plants. The important components are as follows:

	Parts in 100 Parts.	Constitution.	Reaction.	Characters.
1. Morphia	5 to 20	$C_{17}H_{19}NO_3$	Alkaline	See below.
2. Codeia	up to ·6	$C_{18}H_{21}NO_3$	Alkaline	White octahedra or rhombic prisms.
3. Thebaia or Paramorphia	up to ·3	$C_{19}H_{21}NO_3$	Alkaline	White plates, with acrid styptic taste.
4. Opianin ...	·5 to 1	—	—	—
5. Cryptopia		$C_{23}H_{25}NO_5$	Alkaline	—
6. Metamorphia		—	—	—
7. Papaverina		$C_{20}H_{21}NO_4$	Alkaline	White needles.
8. Narcotin ...	4 to 6	$C_{22}H_{23}NO_7$	Alkaline	Shining prisms; tasteless, odourless.
9. Narcein	upto·02	$C_{23}H_{29}NO_9$	Neutral	Fine white needles; odourless, bitter.
10. Porphyroxin ...	—	—	—	—
11. Laudanin ...	—	$C_{26}H_{25}NO_3$	—	—
12. Meconin	·08 to ·3	$C_{10}H_{10}O_4$	Neutral	White needles; odourless, acrid.
13. Meconic Acid	4 to 8	$C_7H_4O_7$	Acid	White crystalline pearly scales.
14. Thebolactic Acid	—	Probably Lactic Acid	Acid	—

General chemical characters, Reactions, and Incompatibles.—A fluid (watery or spirituous) preparation of opium reddens litmus paper (free meconic acid); gives a deep red colour with perchloride of iron (meconic acid); precipitates with acetate and subacetate of lead, nitrate of silver, zinc, copper, and arsenic (meconates, sulphates, and colouring matter); a precipitate with tincture of galls or astringent preparations (tannates of morphia and codeia); and becomes turbid with fixed alkalies, and the carbonates, alkaline earths, and ammonia (precipitated morphia and narcotin).

Dose.—½ to 2 gr.

Preparations.

1. **Emplastrum Opii.**—1 in 10.
2. **Extractum Opii.**—Aqueous. 2 of opium in 1. *Dose*, ½ to 1 gr.

   From Extractum Opii are prepared:

   a. **Extractum Opii Liquidum.**—Made by digesting the Extract in water, and adding spirit. 1 of opium, *i.e.* ½ of extract, in 10. *Dose*, 10 to 40 min.

   b. **Trochisci Opii.**—$\frac{1}{10}$ gr. of Extract in each. *Dose*, 1 to 2.

   c. **Vinum Opii.**—½ of Extract, *i.e.* 1 of opium, in 10 of Sherry, with Cinnamon and Cloves. *Dose*, 10 to 40 min.

3. **Pilula Plumbi cum Opio.**—Opium, 1; Acetate of Lead, 6; Confection of Roses, 1. 1 in 8. *Dose*, 4 to 8 gr.
4. **Pilula Saponis Composita.**—Opium, 1; Hard Soap, 4; water, q.s. 1 in 6. *Dose*, 3 to 5 gr.
5. **Pulvis Opii Compositus.**—Opium, 3; Black Pepper, 4; Ginger, 10; Caraway, 12; Tragacanth, 1. 1 in 10. *Dose*, 2 to 5 gr.

   From Pulvis Opii Compositus is prepared:

   a. **Confectio Opii.**—Compound Powder in Syrup. 1 of opium in 40. *Dose*, 5 to 20 gr.

6. **Pulvis Ipecacuanhæ Compositus.**—Dover's Powder. Opium, 1; Ipecacuanha, 1; Sulphate of Potash, 8. 1 in 10. *Dose*, 5 to 15 gr.

   From Dover's Powder is prepared:

   a. **Pilula Ipecacuanhæ cum Scillâ.**—Compound Ipecacuanha Powder, Squill, Ammoniacum, and Treacle. 1 of opium in 23. *Dose*, 5 to 10 gr.

7. **Pulvis Kino Compositus.**—Opium, 1; Kino, 15; Cinnamon, 4. 1 in 20. *Dose*, 5 to 20 gr.
8. **Pulvis Cretæ Aromaticus cum Opio.**—Opium, 1; Aromatic Chalk Powder, 39. 1 in 40. *Dose*, 10 to 40.

9. **Suppositoria Plumbi Composita.**—Opium, Acetate of Lead, Benzoated Lard, White Wax, and Oil of Theobroma. 1 gr. in each.

10. **Tinctura Opii.**—"Laudanum." Opium, $1\frac{1}{2}$; Proof Spirit, 20. 1 gr. in $14\frac{1}{2}$ min. *Dose*, 5 to 40 min.

From Tinctura Opii are prepared :

a. **Enema Opii.**—Tincture, $\frac{1}{2}$ fl.dr.; Mucilage of Starch, 2 oz. For one enema.

b. **Linimentum Opii.**—Equal parts of Tincture and Soap Liniment.

11. **Tinctura Opii Ammoniata.**—"Scotch Paregoric." Opium, Saffron, Benzoic Acid, Oil of Anise, Strong Solution of Ammonia, and Spirit. 1 in 96. *Dose*, $\frac{1}{2}$ to 1 fl.dr.

12. **Tinctura Camphoræ Composita.**—Opium, Benzoic Acid, Camphor, Oil of Anise, Proof Spirit. $\frac{1}{4}$ gr. in 1 fl.dr. *Dose*, 15 to 60 min.

13. **Unguentum Gallæ cum Opio.**—Opium and Ointment of Galls. 1 in $14\frac{2}{3}$.

From Opium is made :

Morphiæ Hydrochloras.—Hydrochlorate of morphia. $C_{17}H_{19}NO_3.HCl.3H_2O$.

Source.—Made by (1) precipitating and rejecting the meconic acid and resins, by adding a solution of chloride of calcium to a concentrated cold watery infusion of opium; (2) evaporating the solution (containing hydrochlorates of the alkaloids), pressing to remove colouring matter, exhausting with boiling water, filtering, and pressing again; (3) repeating process (2) until solution is nearly colourless; (4) completing decolorisation by digesting with charcoal and filtering; (5) precipitating morphia by ammonia, washing, diffusing in water, dissolving in hydrochloric acid and crystallising out.

Characters.—White acicular prisms of silky lustre; soluble in water and in spirit.

Incompatibles.—The alkaline carbonates, lime-water, salts of lead, iron, copper, mercury, and zinc, liquor arsenicalis, and all astringent vegetables.

Dose.—$\frac{1}{16}$ to $\frac{1}{4}$ gr.

a. **Liquor Morphiæ Hydrochloratis.**—Solution of Hydrochlorate of Morphia. 4 gr. in 1 fl.oz. of a mixture of Spirit, Water, and Diluted Hydrochloric Acid. *Dose*, 10 to 60 min.

b. **Suppositoria Morphiæ.**—$\frac{1}{2}$ gr. in each.

c. **Suppositoria Morphiæ cum Sapone.**—$\frac{1}{2}$ gr. in each.

d. **Trochisci Morphiæ.**—$\frac{1}{36}$ gr. in each.

e. **Trochisci Morphiæ et Ipecacuanhæ.**—$\frac{1}{36}$ gr. with $\frac{1}{12}$ gr. Ipecacuanha in each.

From Morphiæ Hydrochloras is made :

Morphiæ Acetas.—Acetate of Morphia. $C_{17}H_{19}NO_3.C_2.H_4O_2$.

Source.—Made by precipitating morphia from a solution of the hydrochlorate by means of ammonia, dissolving in acetic acid and water, and evaporating.

Characters.—A white powder, soluble in water and in spirit.

Dose.—$\frac{1}{8}$ to $\frac{1}{2}$ gr.

α. **Injectio Morphiæ Hypodermica.**—Hypodermic Injection of Morphia. 1 gr. acetate in 12 min., made by freshly preparing the acetate as above, but without evaporating. *Dose*, hypodermically, 1 to 6 min.

β. **Liquor Morphiæ Acetatis.**—Solution of Acetate of Morphia. 4 gr. in 1 fl.oz. of Spirit, Water, and Diluted Acetic Acid. *Dose*, 10 to 60 min.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Opium is very generally believed to be anæsthetic and anodyne when applied to the unbroken skin, and the emplastrum, linimentum, fomentations, and other preparations are used to relieve the pains of neuralgia, lumbago, abscess, etc. It is doubtful, however, whether morphia can be absorbed by the unbroken skin, and the benefit derived from these applications may be referable to the spirit, resins, and heat. Wounds, ulcers, and exposed mucous surfaces readily absorb opium, which is used in painful ulcers, conjunctivitis, and similar diseases. It is occasionally given by the endermic method, especially in the epigastric region. Hypodermic injection is a most valuable means of administering morphia, when a specially rapid or local effect is desired, or when the stomach is irritable or inaccessible.

Internally.—Opium has a peculiar taste, is quickly absorbed by the mucous membrane, and exerts an action upon the mouth, which, although in part specific and in part remote, is chiefly an immediate local one. A full medicinal dose renders the mouth dry and the tongue foul, from **diminution of the secretions**, with thickness of the voice and some thirst. On entering the stomach opium may cause sickness, from brief irritation of the nerves, but sensibility is quickly reduced, hunger and pain relieved or removed; appetite, gastric secretion, and digestive activity diminished; and the afferent impressions which give rise to vomiting arrested, so that direct emetics will no longer act. Anorexia, nausea, and sickness may occur as *sequelæ* of the same or larger doses.

These effects of opium on the stomach have a double bearing in therapeutics. First, they indicate that it has a constant tendency to **derange digestion.** Secondly, it is a powerful means of relieving gastric pain and vomiting, whatever their cause, but especially in the acute catarrh which remains as the effect of irritant food, alcohol, or poison, after these have been removed; in ulcer, "chronic," or malignant; and in reflex sickness, due to disease, irritation, or operation, in some other part of the abdomen. In chronic dyspeptic pain it is manifestly contra-indicated.

The action of opium on the intestine is distinctly sedative, although very brief primary stimulation may sometimes be recognised. Both the sensible and insensible impressions from the mucous membrane are diminished or arrested by medicinal doses. Pain is prevented or relieved, the secretions are less abundant, and peristalsis is more feeble or arrested; the total result being **anodyne** and **astringent.** Opium is therefore a most valuable remedy for unnatural frequency of the bowels, as in simple diarrhœa, dysentery, the first stage of cholera, the ulceration of typhoid fever and tuberculosis, and irritant poisoning. In all such cases, however, it must be employed with the cautions to be afterwards insisted on, and in most instances it is best prescribed as an addition to other astringents such as chalk, lead, and tannic acid in its many forms; the amount of opium being a minimum, but still sufficient to assist the less powerful drugs. It has the further advantage of relieving abdominal pain. Even infants (see *cautions*, page 197) may thus be treated for diarrhœa with the greatest benefit.

Opium is of still greater service in **paralysing the bowels** in hernia, intestinal obstruction, peritonitis, and visceral perforations, ruptures, and wounds. The drug must be freely and continuously given in such cases, until nature or art can afford relief.

Given by the rectum, as the enema or suppository, opium relieves local pain, diarrhœa, dysentery, and spasm of the rectum or neighbouring parts, sets the pelvic organs at rest after operations, and prevents irritability of the rectum by nutrient enemata. The dose of opium by the rectum should be half as much more as by the mouth. A trace of morphia is excreted unabsorbed in the fæces.

2. ACTION ON THE BLOOD.

Morphia enters the circulation less quickly than some other alkaloids, although the first traces of the drug are rapidly discovered in the blood. Thus its full action is comparatively slowly developed, and solid opium continues to exert local effects even in the colon, portion by portion of the morphia being absorbed into the vessels. The red corpuscles are said to be reduced in size indirectly, possibly through slowing of the circulation and want of oxygen.

3. SPECIFIC ACTION.

After administration morphia may be found in all the organs, which, probably without exception, are physiologically affected by it; but its principal action is exerted upon the nervous system.

The *convolutions* are first briefly excited, and afterwards depressed, probably by direct action of the morphia upon the nerve-cells, not on the cerebral vessels. The stage of opium excitement transcends even the first stage of alcoholic intoxication in the exaltation of feelings, the sense of happiness and comfort, the brilliancy of imagination, and the increase of intellectual power and mental vigour generally, all accompanied by brightness of expression and manner. But the effect of opium, even in this stage, is rarely one of pure exaltation, and in most persons is perhaps never so. There is generally some perversion of the faculties, and the imagination becomes extravagant, wandering into the land of dreams, of the grotesque, and the impossible. Depression now supervenes: the various perceptive and sensory centres in the convolutions are more or less depressed, according to the dose; impressions made upon the afferent nerves, including pain, do not readily affect the receptive centres; the subject becomes drowsy, and finally sleeps; and if he momentarily respond to a sharp enquiry or other forms of stimulation, he quickly relapses into heavy sopor. If the dose has been excessive, the stage of excitement is entirely absent, the cerebrum is speedily and profoundly depressed, and no response follows severe forms of stimulation, such as flagellation: the patient is comatose. These effects of opium on the brain as a **stimulant, hypnotic, anodyne,** and **narcotic,** are more marked in man and in highly intellectual races than in animals and lower races respectively. In cold-blooded animals they are quite subordinate to the effects of stimulation of the cord.

The *ganglia at the base of the brain* are affected by opium, causing **contraction of the pupil,** and disturbance of accommodation.

The grey matter of the *spinal cord* is at first, and briefly, stimulated by a moderate dose of opium, reflex excitability being increased, as shown by restlessness in man and convulsions in animals. At the stage of cerebral depression, languor and muscular weakness, of spinal origin, set in, and the subject lies down; but there is not even then complete loss of muscular power and irritability; and even in dangerous poisoning by opium the patient can be marched about, if supported on either side.

Following close upon the convolutions and cord, the great vital centres in the *medulla* are markedly affected by opium. *Vomiting* is not uncommon as one of the first effects. The *respiratory* centre, at first unaffected, is then depressed, the respiratory movements becoming quiet, superficial, and irregular; and death by opium poisoning is due to **paralysis of the respiratory centre** and arrest of breathing, that is, to asphyxia. The *cardiac* centre is more resistant to morphia, and is first excited so as to increase inhibition (after an evanescent acceleration); but it is soon depressed, and the pulse rises in frequency. The *vascular* centre is depressed by opium, but never to a dangerous extent; and even in complete narcosis, when respiration is failing, the blood pressure (pulse) responds to afferent stimuli. The full action of opium on the respiration, heart, and vessels will be immediately described.

We shall presently find that the therapeutical value of the action of opium on the central nervous system lies in the fact that it depresses the perceptive and sensory centres so much earlier and more profoundly than the vital centres in the medulla. Its effect on the pupil, heart, vessels, respiration, and cord are either of little positive value in treatment, or are altogether unfortunate.

The functions of the *sensory nerve terminations* are lowered or arrested by opium, common sensibility being especially reduced, so that pain cannot be originated; but this peripheral anæsthetic or anodyne effect of morphia given by the mouth is decidedly secondary, both in time and in degree, to its allied action on the sentient centres, and to its local effect when administered by hypodermic or interstitial injection, already described.

The *sensory nerve-trunks* are diminished in conductivity by local injection of morphia, as well as by its internal administration, thus offering a second interruption to the flow of painful impressions inwards.

The *motor nerves* are first briefly excited, and then paralysed from the centre outwards. *Muscular* irritability is never completely lost.

The action of opium upon the centres of several of the *viscera* has been partly described under the previous heads. In addition to this, it **depresses the afferent** (including the sensory) **nerves of all organs**, and acts upon many of the viscera directly.

The *heart* is temporarily accelerated by opium, in part through the cardiac centre, in part through its intrinsic ganglia. Thereafter, or with fuller doses, it is slowed by stimulation of the vagus in the medulla and heart. Finally, the **cardiac vagus is depressed** or paralysed; but by this time the intrinsic ganglia are so depressed that acceleration is impossible, and the action remains infrequent, whilst very feeble. Very rarely death occurs by sudden cardiac failure.

The vessels, dilated through the centre, as described, are not directly influenced by opium, either in their muscular coats, or in their peripheral nerves.

Whilst the *respiratory* movements of the chest are impaired through the centre, so that they become feeble and tend to cease, the afferent nerves of breathing—that is, the branches of the vagus arising in the lungs and passages—are also depressed. Thus reflexion is dulled or arrested at its very origin, and dyspnœal excitement (hyperpnœa), cough, spasm, and other reflex respiratory acts are rendered more difficult or altogether prevented. At the same time, the bronchial secretions are diminished or inspissated by the action of the drug upon the glands, and the activity of pulmonary circulation is lowered with the general blood pressure, and by the weakening of the respiratory movements. The total effect of opium upon the respiratory functions is thus powerfully depressant.

The biliary and glycogenic functions of the *liver* are affected by morphia, which causes pale stools or even jaundice, and remarkably diminishes the amount of sugar in diabetes. **Hepatic and general metabolism is reduced in activity**, the amount of urea and probably of carbonic acid excreted being distinctly diminished. The *temperature* rises for a time, and then falls, apparently varying with the blood pressure.

4. SPECIFIC USES.

The hypnotic and anodyne effects of opium constitute it by far the most valuable drug of its kind, and the most important article of the whole *materia medica*. It is constantly employed to induce sleep, relieve pain, and calm excitement; this combination of properties giving opium a great superiority to chloral and other simple hypnotics, on the one hand, and to aconite, belladonna, quinine, and other direct or indirect anodynes, on the other hand. Speaking broadly, it is used in sleeplessness due to pain; in the insomnia of exhaustion, overwork, fever, or insanity; and in the restlessness and anxiety of visceral disease; the quantity, combinations, and time of administration being carefully arranged. In delirium chloral is often preferred, especially in delirium tremens; but opium is more suitable in the delirium of mania, and in the later stages of fevers, when the temperature is falling and the respiration and circulation are not oppressed. It has been recommended, however, in heat-pyrexia, combined with quinia.

There are but few kinds of pain that cannot be relieved by opium; but whether it be wise to administer it in every instance is another question. The unbearable pains attending the passage of renal and biliary calculi, the pains of neuralgia, acute rheumatism, and cancer; of fractures, dislocation, and other injuries, are a few examples of conditions in which opium is essential. In all cases when pain is urgent, and its seat accessible, the hypodermic method should be chosen. In gout it is to be used only when the pain is excessive, as it tends to aggravate the cause. In hysterical pain it is less valuable. Other local visceral pains will be noticed presently. The pain and shock of operations are constantly treated with a full dose of opium.

No use is made of the action of opium on the iris and ciliary nerves.

As an antispasmodic, opium is less employed for various reasons, *e.g.* in epilepsy and other convulsive diseases; but it relieves some cases of spasmodic asthma, whooping-cough, and spasmodic stricture of the urethra.

The violent spasms and pains of certain diseases of the *cord* may yield to no other form of treatment than morphia injected hypodermically.

From its action on the medulla, opium has been recommended as an antidote to belladonna, which is so far its physiological antagonist, as we shall see (page 198); but it must always be used with great caution, and only in the stage of excitement.

The practical points connected with the vital centres will be noticed under the heart, vessels, and respiration.

In disease of the *heart*, opium is of great value to relieve pain, anxiety, and distress, whilst, as we have seen, it is a dangerous cardiac depressant. Towards the end of most cases of cardiac disease, the greatest discrimination is called for as to when opium may or may not be given. The safe rule is to trust to other anodynes entirely, such as belladonna, direct and indirect stimulants, and measures for relieving the circulation; but it is equally true that in some cases of heart disease unspeakable relief and permanent benefit may be obtained by the hypodermic injection of morphia. This subject must be studied in books on the practice of medicine.

From its soothing effect upon the *vessels* and circulation generally, opium is a **hæmostatic** of the first order, but requires to be used with judgment. In hæmoptysis, it is given in small doses, to relieve cough, to depress the circulation slightly by slowing and weakening the heart and dilating the vessels, and to relieve the mind of the anxiety which aggravates the bleeding. In intestinal hæmorrhage it is of great value, arresting, as it also does, the movements of the bowel. It is best given combined with lead or preparations containing tannic acid.

The soothing influence of opium on the bronchi, lungs, the afferent nerves, and the centre of *respiration*, accounts for its extensive employment in cough, pain, dyspnœa, and other distressing symptoms in the chest. Its power here is unquestionable; but for this very reason the danger of it is great. Cough and dyspnœa are frequently beneficial acts, and are not to be arrested in a routine fashion by sedatives, but, if possible, by the removal of their cause. When cough is due to some irremovable condition, such as growth in the lung or bronchi, pressure, or a remote (reflex) irritation, or to excessive irritability of the nerves and centre, opium is indicated, and may be given with benefit. On the other hand, in cough and respiratory distress with abundant secretion, as in the bronchitis of the old and infirm or of the very young and feeble, opium leads to retention and inspissation of the products, aggravation of the cause, and asphyxia, and is on no account to be given. Between these extremes lies every variety of case in which opium may suggest itself, *e.g.* in phthisis and recurrent bronchial catarrh. The rule here should be on no account to prescribe opium unless other means have failed, such as the many expectorants, and attention to food, warmth, etc.; and that, when given, opium must be ordered in small doses combined with expectorants, such as ammonia and ipecacuanha, which will prevent dangerous depression of the local nerves and centres. In acute inflammation of the pleura, or pleuro-pneumonia, it may be necessary to relieve severe pain in the chest, harassing cough, sleeplessness, and mental distress by morphia hypodermically. For asthma, opium must be ordered with the greatest hesitation, as the opium habit is readily acquired in this disease. Its employment in hæmoptysis has been already noticed.

With respect to the *liver and metabolism*, opium is by far the most powerful drug known in reducing or removing sugar from the urine in diabetes, and therewith ameliorating the condition of the patient in most respects. Very large doses of solid opium, morphia, or better still, codeia, may be tolerated in this disease, their effect on the nervous system being remarkably absent whilst the diabetes is yielding. Acute inflammatory and febrile diseases are now less frequently treated with opium than formerly, when a combination with calomel was generally used, the opium preventing the purgative action of the mercurial, and the latter preventing constipation, whilst both drugs were believed to act specifically on the morbid process, reducing the local general circulation, alleviating pain and restlessness, and promoting healing. The combination is, however, very valuable in syphilis. In the specific fevers, such as typhoid, opium given with judgment relieves delirium, as we have seen, checks diarrhœa, and is invaluable in hæmorrhage, perforation, or peritonitis. With quinia it is given in some cases of malaria. Phagedæna may call for its free exhibition.

Opium is employed in obstetrics to prevent abortion, in some varieties of difficult labour, and to relieve after-pains.

5. REMOTE LOCAL ACTION AND USES.

The excretion of morphia commences quickly, but may not be completed for forty-eight hours. It passes out of the body by most of the secretions, especially the urine, where it is found mainly unchanged. The **quantity of urine is diminished**; its evacuation sometimes disturbed or difficult, from the local action of morphia on the bladder; and sugar occasionally present. These facts, and the probability of the retention and accumulation of morphia in the system if the action of the kidneys be deficient, indicate the necessity to give it only with the greatest caution, in reduced doses, or not at all, in renal disorder or disease.

Opium in passing through the *skin* may cause itching, heat, and sometimes eruptions. The vessels are also dilated, as we have seen, and the sweat glands decidedly stimulated; both being effects of its central, not local, cutaneous action. Thus opium, especially in the form of Dover's powder, is a valuable **diaphoretic**, and is given with great success as a refrigerant apyretic in the outset of catarrh, influenza, and mild febrile or rheumatic attacks caused by cold. Under certain circumstances, Dover's powder actually checks the sweating of phthisis, probably by removing its cause. Being excreted in the milk, opium must be prescribed with caution to nursing females.

6. ACTION AND USES OF THE PRINCIPAL CONSTITUENTS OF OPIUM.

1. **Morphia.**—The **action of opium depends chiefly on morphia,** and the description just given applies so nearly to the

pure alkaloid, that only a few points of difference require to be noticed. These depend upon two principal circumstances: (1) Opium, being much less soluble than the pharmacopœial preparations of morphia, is more slowly absorbed, and thus acts less quickly than morphia, whilst its effects are more lasting, and its immediate local action on the intestines decidedly more marked. (2) Several of the constituents of opium possess more or less convulsant action (thebain, codeia, narcotin), morphia none (in man); the latter has therefore a somewhat more sedative influence than the entire drug. The effect of opium on the skin is also less marked in morphia. Unless there be some special reason to the contrary, morphia is generally to be preferred to opium in practice, as being of definite composition (whilst the crude drug is very variable), more rapid in action, readily administered hypodermically, whilst the dyspeptic and constipating effects of the drug are less marked. Opium is to be preferred in intestinal and abdominal diseases such as diarrhœa, obstruction, peritonitis, hernia, because it reaches the bowel; in delirium tremens and mental disorder, because its action is more continued; in diabetes, because it contains codeia; for combinations with quinine or calomel, and as a diaphoretic, because it prevents purgation and lowers fever; in astringent enemata, from its action on the bowel; and for local applications, *e.g.* to the conjunctiva, because less irritant than the alkaloid. The relative strength of opium to morphia is about 20 or 30 to 100, $\frac{1}{5}$ or $\frac{1}{3}$ to 1.

2. *Codeia.*—This alkaloid appears to **excite the cord** more than morphia, and to depress the convolutions less, so that muscular tremors may follow and exceed the sedative influence. Codeia, in $\frac{1}{2}$-gr. doses cautiously increased, markedly **reduces the amount of sugar** in diabetes, appearing to act as an alterative to the nervous system, and thus to cure (not simply relieve) the disease in some instances.

3. *Narcotin*, which is so large a constituent of opium, is probably often impure from an admixture of morphia. By some authorities it is considered to be **hypnotic,** by others convulsant. It is not used.

4. *Narceïn* probably **acts like morphia,** and is not employed medicinally.

5. *Thebain* is a **convulsant,** almost like strychnia, but is not used.

6. Opianin, cryptopia, metamorphia, and possibly papaverina, **act like morphia.** Porphyroxin and laudanin **act like codeia.**

The action of meconic acid is doubtful.

7. APPLICATIONS OF THE VARIOUS PREPARATIONS OF OPIUM.

This subject will be best discussed from the point of view of the conditions calling for opium.

1. *Severe pain*, such as colic or neuralgia, is to be treated with the Hypodermic Injection of Morphia. Failing this, either of the Solutions of Morphia must be given by the mouth, or a fluid preparation of opium, such as the Tincture, or Liquid Extract (about ⅐ more active than the tincture). The Enema is a valuable anodyne in cases of abdominal pain. The Pilula Saponis Composita also acts rapidly, being more readily soluble in the stomach than solid opium.

2. *Superficial pain* may be met by local applications such as the Plaster, Liniment, or fomentations made with laudanum or other fluid preparation; but, as we saw, the value of the drug itself in all these applications is very doubtful.

3. *As a hypnotic*, the best forms are the Tincture, the Liquid Extract, the Solution of Morphia, and the Soap and Opium Pill; the particular preparation and the dose being regulated by the degree of sleeplessness and of the pain which may accompany it. Dover's Powder is an excellent hypnotic in the restlessness at the commencement of feverish attacks.

4. As a *sedative to the stomach*, various preparations may be tried, such as the Solutions of Morphia in effervescing mixtures, morphia endermically or hypodermically over the epigastrium; sometimes solid opium or the Extract in the form of a small pill. Dover's Powder is of great value in painful ulceration and acute dyspepsia, combined with bismuth or soda.

5. As a *sedative and astringent to the bowels*, Laudanum, either by the mouth or as the Enema, may be given in urgent cases attended by much pain. When there is less urgency, we may prescribe one of the powders—Compound Opium Powder, Chalk and Opium, Kino and Opium, or Dover's Powder. Acetate of morphia with acetate of lead and acetic acid, or the Lead and Opium Pill may be demanded in severe diarrhœa, especially if hæmorrhage threaten. Solid opium, alone or combined with calomel, is the best form of astringent when the bowel must be paralysed, as in hernia, peritonitis, and intestinal obstruction.

6 As *a sedative to the rectum*, bladder, pelvic organs, and urethra, we possess the various Suppositories of opium and morphia, and the Enema.

7. *Cough* may be relieved by several special preparations, namely: Tinctura Camphora Composita, Tinctura Opii Ammoniata, the three Trochisci, and the Pilula Ipecacuanhæ cum Scilla.

8. *Diaphoresis* is generally accomplished with Dover's Powder.

The uses of the other preparations are obvious. The Confection is a pleasant form of the compound powder.

Influences modifying the action and uses of opium.—Dangers: Cautions.—*Age* modifies greatly the effects of opium, children being particularly susceptible of its influence on the convolutions and medulla. An infant of one year should not be given more than half a minim of the tincture for an ordinary dose, and suckling women should be ordered opium with special precautions. *Females* are more easily affected than males. Certain individuals have peculiar *idiosyncrasies* as regards opium, some resisting its action, others being excited by it, others again very readily narcotised; whilst more frequently some persons suffer from a species of shock after the hypodermic injection of morphia, becoming sick, faint, and even alarmingly collapsed. The effect of *habit* is extremely marked in opium, the necessary dose steadily rising, until large quantities may be safely taken. *Disease*, especially *pain*, affords great resistant power to the action of opium, which appears to expend its action on the morbid process. The quality of the opium, the particular preparation, and the combinations used, also modify its action. On the contrary, opium and morphia act more powerfully in the subjects of kidney disease, as we have already seen. Morphia and opium are *contra-indicated*, because dangerous, or are to be used with special care, in diseases of the respiratory organs, the heart, and the kidneys; in congestive conditions and hyperæmia of the brain; and in alcoholic intoxication.

Opium and Belladonna: Combinations and Antagonism of Morphia and Atropia.—In several respects the action of morphia is opposed to that of atropia, the important principle of belladonna. The *antagonism* between the two substances is in part real, such as their respective effects on the convolutions, respiratory centre, and intestines; in part apparent only. Thus, the contraction of the pupil caused by morphia occurs through the basal ganglia; the dilatation caused by atropia is referable to paralysis of the ciliary branches of the third nerve. Morphia is a diaphoretic through the centres: atropia an anhidrotic through the terminal nerves of the glands. Both depress the heart and reduce the blood pressure, in poisonous doses. Thus, morphia and atropia are not true antagonists, but the one may prevent or relieve certain effects of the other, and may therefore be combined with the other for particular medicinal purposes, or given in the treatment of poisoning by the other under particular circumstances. *Combinations* of atropia and morphia are now extensively used for hypodermic injection ($\frac{1}{100}$, $\frac{1}{60}$, or even $\frac{1}{25}$ gr. of sulphate of atropia to 1 gr. of morphia), to prevent certain unpleasant effects of the latter. It is found that the immediate sickness and depression, and the subsequent dyspepsia and constipation, may thus be avoided, and a more natural sleep induced. The combination is preferable when morphia is given as a hypnotic or anodyne; in conditions of cardiac depression and disease of the lungs; in obstruction of the bowels; and to relieve spasms in general. The atropia should be avoided in cerebral excitement, especially mania.

Use as mutual antidotes.—Sulphate of atropia, in doses of $\frac{1}{100}$ gr., may be injected subcutaneously every quarter of an hour in opium poisoning, the pulse and respiration being carefully watched. Three or four doses may thus be given; but the ordinary means of resuscitation, especially artificial respiration, must not be for a moment interrupted.

In poisoning by belladonna, morphia should be given subcutaneously, with the same precautions, in doses of $\frac{1}{4}$ of a grain.

Apomorphia. $C_{17}H_{17}NO_2$. Apomorphia. (*Not Officinal.*)

Source.—Made by heating morphia in a closed tube, with concentrated hydrochloric acid, whereupon the alkaloid loses one molecule of water—$C_{17}H_{19}NO_3 = C_{17}H_{17}NO_2 + H_2O$.

Characters.—A white powder, becoming green on exposure or in solution, without loss of its properties. Soluble in ether and alcohol. The hydrochlorate of apomorphia, which is generally used, occurs as minute greyish crystals, soluble in water. Solutions should be freshly prepared for use.

Dose of the hydrochlorates.—$\frac{1}{10}$ to $\frac{1}{6}$ gr., by the mouth; $\frac{1}{20}$ to $\frac{1}{10}$ gr., hypodermically.

ACTION AND USES.

Apomorphia is the most certain of all emetics, acting upon the vomiting centre, and not on the stomach, *i.e.* being an **indirect emetic.** In from five to twenty minutes it induces moderate nausea, repeated vomiting, and the disturbances of the respiratory and circulatory organs, characteristic of this class of remedies. If the dose have been sufficient, the evacuation of the stomach is certain and complete. Larger doses cause prostration and paralysis of the voluntary muscles, depression of the respiratory centre, acceleration of the heart, and fall of temperature, Small doses are **expectorant.** Apomorphia may be used for the many purposes of emetics in general. Its special advantages consist in its certainty; the absence of local irritation of the stomach; the readiness with which it can be given hypodermically, that is, to patients unable to swallow, as a small non-irritant injection; and the absence of after-effects. Its expectorant action has been but little employed.

Rhœados Petala—RED-POPPY PETALS.—The fresh petals of Papaver Rhœas. From indigenous plants.

Characters.—Of a scarlet colour and heavy poppy odour.

Composition.—Red poppies contain a large quantity of colouring matter, readily soluble in water, consisting of two acids, *papaveric* and *rhœadic acids;* also an alkaloid *rhœadin*, $C_{21}H_{21}NO_6$, without narcotic properties. Red poppies contain no morphia.

Preparation.

Syrupus Rhœados.—1 in 3½. *Dose*, 1 fl.dr.

ACTION AND USES.

Syrup of red poppies is used as a **colouring agent** only.

CRUCIFERÆ.

Sinapis—MUSTARD.—The seeds of Sinapis Nigra, and Sinapis Alba; also the seeds reduced to powder, mixed.

Characters of the Powder.—Greenish-yellow, of an acrid bitterish oily pungent taste, scentless when dry, but exhaling when moist a pungent penetrating peculiar odour, very irritating to the nostrils and eyes. *Impurity.*—Starch; a decoction cooled should not be made blue by tincture of iodine.

Substances resembling black mustard: Colchicum seeds, which are larger, lighter, and not quite round.

Composition.—The seeds of *sinapis nigra* contain: (1) about 35 per cent. of a bland *fixed oil.* When this has been removed by expression, and the powdered mustard mixed with water and distilled, there is obtained (2) the officinal *volatile oil, Oleum Sinapis*, C_4H_5NS. This is a colourless or pale yellow body, nearly insoluble in water, of intensely penetrating odour, burning taste, and blistering action on the skin. As the seeds and powder of the mustard are devoid of these irritant properties, the oil cannot exist ready formed in them, but is developed by a decomposition of their constituents. On the addition of water to the black mustard, its most important principle, *potassium myronate* or *sinigrin* ($C_{10}H_{18}NKS_2O_{10}$), a compound of potassium with an acid glucoside, *myronic acid*, is broken up by another constituent, *myrosin*, a ferment, into volatile oil of mustard, potassium sulphate, and sugar, thus: $K,C_{10}H_{18}NS_2O_{10} = C_4H_5NS + KHSO_4 + C_6H_{12}O_6$. *Sinapis alba* also contains the fixed oil. It does not, however, yield the volatile oil, but a substance with allied properties, called *sulphocyanate of acrinyl*, C_8H_7NSO, by a similar decomposition of its constituents, *sinalbin*, $C_{30}H_{44}N_2S_2O_{16}$ (in place of potassium myronate) and myrosin, thus: $C_{30}H_{44}N_2S_2O_{16} = C_8H_7NSO + C_{16}H_{23}NO_5,H_2SO_4$ (disulphate of sinapin) $+ C_6H_{12}O_6$ (glucose).

Preparations.

1. **Oleum Sinapis.**—The oil distilled with water from the seeds of Sinapis nigra after the expression of the fixed oil. Solubility, 1 in 50 of water; readily in spirit and ether.

From Oleum Sinapis is prepared:

a. **Linimentum Sinapis Compositum.**—1 in 41, with Ethereal Extract of Mezereon, Camphor, Castor Oil, and Spirit.

2. **Cataplasma Sinapis.**—Mustard in powder, linseed meal, and boiling water.
3. **Charta Sinapis.**—Made with guttapercha solution.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—When applied to a limited area of skin mustard acts quickly (1) as a **rubefacient** and nervous **stimulant,** causing redness, heat, and severe burning pain. (2) This effect is speedily followed by **loss of sensibility** in the part to other impressions, and relief of previous pain. (3) The prolonged application of the charta or cataplasm causes **vesication** by the production of local inflammation. Neighbouring and deeper parts, and viscera in vascular communication or intimate nervous relation with the blistered area, may thus have their circulation relieved. The heart, blood pressure, respiration, and nervous centres generally are stimulated by the first application of mustard to the skin; soothed during the stage of anæsthesia, and relief of pain; and depressed in the third stage, especially if the vesication be severe through neglect. Applied to the whole or a large part of the surface of the skin in the form of a bath, mustard dilates the cutaneous vessels, and thus relieves the blood pressure in the viscera.

In the form of poultice or paper, mustard is extensively used as a readily available, convenient, and rapid means of relieving local pain, stimulating the internal organs, and producing **counter-irritation,** with evanescent and mild after-effects. It is applied to relieve the pains of muscular rheumatism (lumbago, etc.); neuralgia in any part of the body; the indefinite pains in the chest in chronic disease of the lungs or heart; and colic, gastralgia, and other forms of distress in the abdomen. As a cardio-vascular and respiratory stimulant, a large sinapism may be applied to the calves or soles in syncope, coma, or asphyxia, whether from disease or from poisoning. The counter-irritant effect of mustard is chiefly used in inflammation of the throat, larynx, bronchi, lungs, pleura, and pericardium; sometimes in abdominal diseases; frequently, and with success, in morbid conditions of the stomach, and persistent vomiting from any cause. Diffused through a warm bath it is a popular "derivative" in cerebral congestions, headache, and at the onset of colds and febrile diseases in children. A mustard sitz bath may stimulate menstruation if taken at the period.

Internally.—Mustard produces a familiar pungent impression on the tongue and olfactory organs, a sense of warmth in the stomach, and an increase of relish and appetite. The circulation in the gastric wall is also stimulated, but it is remarkable that the effect of mustard on the circulation in the stomach is much less powerful than that on the skin. In full doses it is emetic, with a rapid stimulant action, and little subsequent depression.

Mustard is used internally chiefly as a **condiment.** As an **emetic,** from one to four teaspoonfuls may be given stirred up with a tumblerful of warm water in cases where other emetics are not available, or have failed, especially in poisoning by narcotics such as opium.

2. ACTION ON THE BLOOD, SPECIFIC, AND REMOTE LOCAL ACTION.

The odour of oil of mustard can be detected in the blood. Its specific action is obscure, and never taken advantage of medicinally. Part, at least, of oil of mustard is excreted by the lungs.

Armoraciæ Radix—HORSERADISH ROOT.—The fresh root of Cochlearia Armoracia. Cultivated in Britain.

Characters.—A long cylindrical, fleshy root, half an inch to one inch in diameter, expanding at the crown into several very short stems. It is internally white, and has a pungent taste and smell.

Substances resembling Horseradish: Aconite root, which is short, conical, darker, and causes tingling when chewed.

Composition.—Horseradish yields, along with other constituents, a *volatile oil*, C_4H_5SN, closely allied to the volatile oil of black mustard, and formed, like it, by decomposition of a more complex principle by means of a ferment.

Preparation.

Spiritus Armoraciæ Compositus.—1 in 8, with orange-peel, nutmeg, and spirit. *Dose,* 1 to 2 fl.dr.

ACTION AND USES.

Horseradish has been used in domestic medicine as a counter-irritant, but is most familiar as a pleasant condiment, possessing much the same properties as mustard. The compound spirit is a **flavouring and carminative agent.**

POLYGALACEÆ.

Senegæ Radix—SENEGA ROOT.—The dried root of Polygala Senega. From North America.

Characters.—A knobby root-stock, with a branched tap-root, of about the thickness of a quill, twisted and keeled; bark yellowish-brown; sweetish, afterwards pungent, causing salivation; interior woody, tasteless, inert.

Substances resembling Senega: Veratrum Viride, Arnica, Valerian, Serpentary. All have no keel.

Composition.—The active principle of senega is *saponin*, a colourless amorphous glucoside, $C_{32}H_{54}O_{18}$, decomposed by HCl into a sugar, and *sapogenin* ($C_{14}H_{22}O_2$). Saponin is closely allied to *digitonin*, one of the active principles of digitalis.

Preparations.

1. **Infusum Senegæ.**—1 in 20. *Dose,* 1 to 2 fl.oz.
2. **Tinctura Senegæ.**—1 in 8. *Dose,* $\frac{1}{2}$ to 2 fl.dr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Applied to the mucous membrane of the nose or throat, in the form of powder (snuff), senega is a powerful irritant, causing reflex hyperæmia, sneezing, cough, and mucous flow. These effects are not employed, but are a key to its remote local action. Solutions of saponin injected under the skin are violent local irritants and general depressants; the heart, vessels, central and peripheral nervous system, and muscles being dangerously affected.

Internally.—The action of senega on the stomach and intestines is moderately irritant, large doses causing epigastric heat, sickness, and diarrhœa; and medicinal doses **deranging digestion.** The absence of severe general symptoms indicates the difficulty of its absorption by the stomach.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION.

Saponin passes through the blood to the tissues. Senega diminishes the frequency of the heart, and probably affects the circulation much like digitalis, but in a manner which is more uncertain or at least still obscure.

3. REMOTE LOCAL ACTION AND USES.

Saponin appears to be excreted in part by the bronchial mucosa, which it stimulates thus remotely as it does when locally applied. The circulatory, muscular, and nutritive activity of the tubes is increased; the mucous secretion rendered more abundant and watery; and the efferent nerves stimulated, so that reflex cough is the result. The total action is said to be **expectorant,** the bronchial contents being expelled with greater force, and in greater volume, *i.e.* more readily and easily. Senega is in common use as a stimulant expectorant in the second stage of acute bronchitis, in chronic bronchitis, and in dilated bronchi, to liquefy and evacuate the contents of the tubes or cavities, and stimulate the "weak" surface of the mucous membrane. It is manifestly contra-indicated in acute bronchitis, phthisis, and when the digestion is feeble or deranged. Saponin is probably excreted in part by the skin and kidneys, both of which it slightly stimulates, increasing the volume of urine, and its most important solid constituents.

Krameriæ Radix—RHATANY ROOT.—The dried root of Krameria triandra. Imported from Peru.

Characters.—About an inch in diameter, branches numerous, long, brownish-red and rough externally, reddish-yellow internally, strongly astringent, tinging the saliva red.

Composition.—Rhatany root contains from 20 to 45 per cent. of *rhatania-tannic acid*, $C_{54}H_{24}O_{21}$, a red amorphous substance, the watery solutions of which first colour chloride of iron green and then precipitate it, but are not precipitated by tartar emetic.

Incompatibles.—Alkalies, lime-water, salts of iron and lead, gelatine.

Preparations.

1. **Extractum Krameriæ.**—Aqueous. *Dose*, 5 to 20 gr.
2. **Infusum Krameriæ.**—1 in 20. *Dose*, 1 to 2 fl.oz.
3. Pulvis Catechu Compositus.—1 in 5.
4. **Tinctura Krameriæ.**—1 in 8. *Dose*, 1 to 2 fl.dr.

ACTION AND USES.

The preparations of rhatany possess the **properties of tannic acid**, and may be employed for the same purposes (see *Acidum Tannicum*, page 337), except that they are obviously of no use in poisoning by antimony. The drug is not extensively ordered.

SAPINDACEÆ.

Guarana. (*Not Officinal.*)—The seeds of Paullinia sorbilis, reduced to powder after roasting, and made into a stiff paste with water. From Brazil.

Characters.—Cylindrical rolls of dried paste. Brazilian cocoa.

Composition.—Guarana contains no less than five per cent. of *caffein*, $C_8H_{10}N_4O_2$, the alkaloid of the coffee and tea plants; united, as in these, with *tannic acid*, *starch*, and *gum*.

Dose.—15 to 60 gr. in powder, or as infusion.

ACTION AND USES.

The action of guarana closely **resembles that of strong tea** or coffee. It is chiefly used in sick headache (megrim). See *Caffein* (page 271).

ERYTHROXYLACEÆ.

Coca. (*Not Officinal.*)—The leaves of Erythroxylon Coca. From South America.

Characters.—Leaves two inches long, petiolate, oval, entire, pointed at the blunt apex, with a slight odour of tea, and a bitter aromatic taste.

Composition.—Coca leaves contain a yellowish-white crystalline bitter alkaloid, *cocaïn*, $C_{17}H_{21}NO_4$, which is converted by heat into a second alkaloid, *ecgonin*, $C_9H_{15}NO_3$, benzoic acid, and methylic alcohol.

Dose.—$\frac{1}{2}$ to 4 dr. of the leaves; $\frac{1}{8}$ to 1 gr. of cocaïn.

ACTION AND USES.

Coca is believed to possess **stimulant, restorative**, or even **nutritive** properties, enabling persons who chew the leaf to undergo great muscular exertion with little or no fatigue. In animals the alkaloid causes great muscular restlessness or excitement, and finally convulsions; the whole brain, medulla, and cord being powerfully stimulated. The pupils are dilated; respiration rises in frequency, is disturbed in rhythm, and finally ceases. The heart is greatly accelerated by paralysis of the vagus; the blood pressure first rises and then falls. The muscles themselves remain unaffected. The amount of urea is said to be diminished, as if from diminished metabolism; but coca does not prolong the life of starved animals.

This drug has been used to prevent muscular exhaustion; in wasting attended with increased formation of urea (azoturia); in convalescence; in mental exhaustion; and in the opium habit. It has somewhat disappointed expectation.

LINACEÆ.

Lini Semina—LINSEED.—The seeds of Linum usitatissimum, Flax. Cultivated in Britain.

Characters.—Small, oval, pointed, flat, with acute edges, smooth shining brown externally, yellowish-white within, of a mucilaginous oily taste.

Composition.—The seeds of flax contain a quantity of *mucilage*, chiefly in the *testa* or coat, and from $\frac{1}{4}$ to $\frac{1}{3}$ of their weight of the officinal *fixed oil*. This consists chiefly of the glyceride of *linoleïc acid*, which has a powerful affinity for oxygen, and thus becomes resinoid on exposure, constituting it a "drying oil." The linseed meal, obtained after expression of the oil, consists chiefly of mucilage, proteids, salts, a little oil, but neither starch nor sugar.

Preparations.

1. **Farina Lini.**—Linseed Meal. Linseed ground and deprived of oil, and the cakes powdered.

From Farina Lini is prepared :

a. Cataplasma Lini.—Mix Linseed Meal 4, with boiling Water 10, and add Olive Oil ½, stirring constantly. Freshly bruised linseed is better than the meal and olive oil.

Linseed meal is also used in preparing all Cataplasmata except Cataplasma Fermenti.

2. **Infusum Lini.**—"Linseed Tea," 1 in 30, with Liquorice. *Dose*, ad libitum.
3. **Oleum Lini.**—Brown. Made by expression without heat.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Linseed meal is used only as the cataplasma, which is the poultice universally employed to **convey heat and moisture** to parts, and thus affect the nerves, circulation, and nutrition generally. The oil may be applied to burns, either pure or mixed with an equal quantity of lime-water, constituting carron oil, a substitute for Linimentum Calcis. It may also be used as a laxative in the form of enema.

Internally.—Infusum Lini, or "linseed tea," is a familiar **demulcent** drink, containing a large quantity of mucilage, which coats the surface of the pharynx and fauces, and thus relieves troublesome throat cough, especially when it is combined with a little stimulant lemon.

2. ACTION IN THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTION.

Linseed tea is supposed to have a specific and remote local effect as a demulcent on the bronchi and urinary passages, but this is probably referable to the warm water only. It is, perhaps, **slightly diuretic** as oil of linseed becomes oxydised in the system (as it does on exposure to air), and is excreted by the kidneys as a resinoid body which stimulates these organs.

MALVACEÆ.

Gossypium—COTTON WOOL.—The hairs of the seed of several species of Gossypium, carded.

Preparations.

Pyroxylin. Gun Cotton.—Made by immersing the wool in a mixture of sulphuric and nitric acids, washing, draining, and drying.

From Pyroxylin is prepared:

Collodium.—Made by dissolving Pyroxylin, 1; in Ether, 36; and Rectified Spirit, 12.

From Collodium is prepared:

Collodium Flexile.—Collodium, 48; Canada Balsam, 2; and Castor Oil, 1.

Non-officinal Preparation of Gossypium.

Absorbent Cotton Wool. Cotton wool deprived of its oil by washing with an alkali.

ACTION AND USES.

The action and uses of cotton wool in medical and surgical practice are sufficiently familiar. Absorbent cotton is now much employed.

Pyroxylin is introduced for the purpose of making collodion.

Collodion, when painted on the skin or other exposed part, instantly dries by evaporation of the ether, forming a fine film. This film serves as a **protective** to thin, inflamed, broken, or incised surfaces, preventing bed-sores, arresting hæmorrhage (as in leech-bites), and closing fissures or punctures made with aspirateurs or trochars in paracentesis. The *flexible collodion* does not contract on drying or readily crack, and is a better form for most of the above purposes.

AURANTIACEÆ.

Aurantii Cortex—BITTER-ORANGE PEEL.—The dried outer part of the rind of the bitter orange, Citrus Bigaradia. From the ripe fruit imported from the south of Europe.

Characters.—Thin, of a dark orange colour, nearly free from the white inner part of the rind, having an aromatic bitter taste and fragrant odour.

Composition.—Orange peel contains 1 to 2½ per cent. of volatile oil, *oleum corticis aurantii*, isomeric with oil of turpentine, $C_{10}H_{16}$, and a bitter crystalline principle, *aurantiin* or *hesperidin*.

Preparations.

1. **Infusum Aurantii.**—1 in 20. *Dose*, 1 to 2 fl.oz.
2. **Infusum Aurantii Compositum.**—1 in 40. *Dose*, 1 to 2 fl.oz.

3. **Tinctura Aurantii.**—1 in 10. *Dose*, 1 to 2 fl.dr.

From Tinctura Aurantii is prepared:

a. **Syrupus Aurantii.**—1 of tincture in 8.

Tinctura Aurantii is also an ingredient of Mistura Ferri Aromatica and Tinctura Quiniæ.

4. **Vinum Aurantii.**—Orange wine made in Britain, and containing 12 per cent. of alcohol.

Vinum Aurantii is used in making Vinum Ferri Citratis and Vinum Quiniæ.

Bitter-orange peel is also an ingredient of Spiritus Armoraceæ Compositus, Tinctura Cinchonæ Composita, and Infusum Gentianæ Compositum, Mistura Gentianæ, and Tinctura Gentianæ Composita.

Aurantii Fructus—BITTER ORANGE.—The ripe fruit of Citrus Bigaradia. Imported from the south of Europe.

Preparation.

Tinctura Aurantii Recentis.—6 in 20. *Dose*, 1 to 2 fl.dr.

Aqua Aurantii Floris—ORANGE-FLOWER WATER.—Water distilled from the flowers of the bitter-orange tree, Citrus Bigaradia, and of the sweet-orange tree, Citrus aurantium. Prepared mostly in France.

Characters.—Nearly colourless, fragrant.

Composition.—Orange flowers yield an aromatic volatile oil, *oleum neroli*, and a trace of a bitter principle.

Impurities.—Lead derived from the vessels in which it is imported; detected by H_2S. *Dose*, ½ to 1 fl.oz.

Preparation.

Syrupus Aurantii Floris.—*Dose*, 1 to 2 fl.dr.

ACTION AND USES.

Orange is at once an **aromatic and a bitter** substance, and combines the action of these two classes of remedies, as described under *Calumba* and *Caryophyllum* respectively. It is extensively used as a highly agreeable flavouring agent in cookery, pharmacy, and the manufacture of liqueurs; and in these several ways may be turned to account therapeutically. It is but feebly bitter.

Limonis Cortex—LEMON PEEL.—The outer part of the rind of the fresh fruit of Citrus Limonum. Lemons are imported from southern Europe.

Composition.—Lemon peel contains the officinal volatile oil, *Oleum Limonis*, $C_{10}H_{16}$ (isomeric with turpentine), and a bitter principle.

Preparations.

1. **Oleum Limonis.**—The oil expressed or distilled from the fresh peel. Pale yellow. *Dose,* 1 to 4 min.
   Oil of Lemon is an ingredient of Linimentum Potassii Iodidi cum Sapone and Spiritus Ammoniæ Aromaticus.
2. **Syrupus Limonis.**—2 in 41, with 20 of Lemon Juice. *Dose,* 1 to 2 fl.dr.
3. **Tinctura Limonis.**—1 in 8. *Dose,* ½ to 2 fl.dr.

Lemon peel is also contained in Infusum Aurantii Compositum and Infusum Gentianæ Compositum.

ACTION AND USES.

The action and uses of lemon are the same as those of orange, the only difference of importance being in the flavour. See *Aurantii Cortex.*

Limonis Succus—LEMON JUICE.—The freshly expressed juice of the ripe fruit of Citrus Limonum.

Characters.—A slightly turbid yellowish liquor, with a sharp acid taste, and grateful odour. Half a fluid ounce (one table-spoonful) contains 16·25 gr. of Citric Acid, and neutralises 23 gr. nearly of Bicarbonate of Potash, 20 gr. nearly of Bicarbonate of Soda, or 13 gr. fully of Carbonate of Ammonia.

Composition.—Lemon juice contains *citric acid*, both free and combined with *potash* and other bases, malic and phosphoric acids, etc.

Dose.—½ to 4 fl.oz.

Preparations.

1. **Syrupus Limonis.**—See *Limonis Cortex.*
2. **Acidum Citricum.**—See *Acids*, page 126.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Lemon juice in the mouth and stomach has the same action as citric acid, and is used chiefly to **relieve thirst** and **produce effervescing** mixtures and drinks.

2. ACTION ON THE BLOOD, AND SPECIFIC ACTION AND USES.

Lemon juice enters the blood as alkaline citrates, potash salts, and phosphoric acid. Here the citrates are in part oxydised into carbonic acid and water. (See *Acidum Citricum.*) The potash and phosphoric acid probably act upon the red corpuscles, of which they are both important constituents.

Lemon juice is used with great success in the prevention and **treatment of scurvy,** a disease the exact nature of which is still obscure, but which is no doubt produced by the want of the juices of fresh vegetable and animal food. The citric acid, the potash, and the phosphoric acid have severally been credited with the beneficial effect by different authorities. Lemon juice has also been given in acute rheumatism, but is probably useful only in as far as it conveys alkalies into the blood and tissues.

3. REMOTE LOCAL ACTION AND USES.

These, which are of great importance, are fully described under Citric Acid.

Belæ Fructus—BAEL FRUIT.—The dried half-ripe fruit of Ægle Marmelos. From Malabar and Coromandel.

Characters.—Fruit roundish, about the size of a large orange, with a hard woody rind; usually imported in dried slices, or in fragments consisting of portions of the rind and adherent dried pulp and seeds. Rind about a line and a half thick, covered with a smooth pale-brown or greyish epidermis, and internally, as well as the dried pulp, brownish-orange or cherry-red. The moistened pulp is mucilaginous.

Composition.—Bael is believed to contain a kind of tannic acid, but has not been thoroughly analysed.

Preparation.

Extractum Belæ Liquidum.—1 in 1. *Dose*, 1 to 2 fl.dr.

ACTION AND USES.

In the fresh state, Indian bael is a pleasant refreshing fruit, with **astringent and refrigerant** properties, which render it valuable in the treatment of diarrhœa and dysentery. As imported into this country in hard portions of rind and dried pulp it is probably useless; but a liquid extract made from the fresh fruit appears to produce its specific effects. It is seldom employed out of India.

BYTTNERIACEÆ.

Oleum Theobromæ—OIL OF THEOBROMA.—Synonym: Cacao Butter. A concrete oil obtained by expression and heat from the ground seeds of Theobroma cacao, a small tree, a native of Demerara and Mexico.

Characters.—Of the consistency of tallow; colour yellowish, odour resembling that of chocolate; taste bland and agreeable; fracture clean, presenting no appearance of foreign matter. Does not become rancid from exposure to the air. Melts at 95°. The seeds also contain theobromin. See *Caffein*, page 270.

Composition.—Oil of theobroma constitutes from 30 to 50 per cent. of the cacao bean. It consists chiefly of stearin with a little olein.

Preparations.

All the suppositories.

ACTION AND USES.

Cacao butter serves as a **vehicle** for more active substances in the form of suppositories. The action of theobromin is the same as that of caffein. See page 271.

CAMELLIACEÆ.

Tea. (*Not Officinal.*)—The dried leaves of Thea sinensis.

Composition.—Tea contains an alkaloid, *thein*, $C_8H_{10}N_4O_2$, identical with caffein; a *volatile oil*, most abundant in green tea, and *tannin*. The relations of the alkaloid, as well as its

ACTION AND USES,

are described fully under *Caffein*, page 271.

GUTTIFERÆ.

Cambogia—GAMBOGE.—A gum-resin obtained from Garcinia Morella. Imported from Siam.

Characters.—Cylindrical pieces, breaking easily with a smooth conchoidal glistening fracture; colour tawny, changing to yellow when it is rubbed with water; taste acrid.

Dose.—1 to 4 gr.

Impurity.—Starch; detected by yielding a green colour with iodine.

Composition.—Gamboge contains about 73 per cent. of a resinous substance, *gambogic acid*, $C_{20}H_{23}O_4$; 25 per cent. of *gum*; and about 2 per cent. of water. Gambogic acid is insoluble in water, gives the brilliant yellow colour to the gum-resin, and forms salts with bases. It is less active than the gum-resin.

Preparation.

Pilula Cambogiæ Composita.—Gamboge, 1; Barbadoes Aloes, 1; Compound Powder of Cinnamon, 1; Hard Soap, 2; Syrup, q. s. *Dose*, 5 to 10 gr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Gamboge is an **irritant** to the stomach and bowels, causing vomiting in large doses, and in medicinal doses acting as a **hydragogue cathartic** not unlike colocynth, without being cholagogue. It is seldom prescribed alone, and not often as the compound pill. Such a remedy is indicated in dropsies, cerebral hyperæmia, and as an anthelmintic (not to children); but other substances have now almost completely displaced it.

2. ACTION IN THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTION AND USES.

Gambogic acid is chiefly thrown out in the liquid fæces; but part is absorbed, passes through the blood and tissues, and is excreted by the kidneys. These it stimulates, causing an increased flow of yellow-coloured urine. Its **diuretic** effect may add to its value in dropsy.

CANELLACEÆ.

Canellæ Albæ Cortex—CANELLA ALBA BARK.—The bark of Canella alba. From the West Indies.

Characters.—In quills or broken pieces, hard, of a yellowish-white or pale-orange colour, somewhat lighter on the internal surface. It has an aromatic clove-like odour, and an acrid peppery taste.

Composition.—Canella contains a *bitter principle* and an *aromatic oil.*

Canella Alba is contained in Vinum Rhei. (See *Rhei Radix,* page 318.)

ACTION AND USES.

Canella alba is an **aromatic bitter** stomachic and tonic, like cascarilla and cinnamon. The action and uses of this class of remedies is fully described under *Calumbæ Radix*, page 181.

VITACEÆ.

Uvæ—RAISINS.—The ripe fruit of Vitis vinifera, the Grape Vine, dried in the sun or with artificial heat. Imported from Spain.

Composition.—Raisins contain *grape sugar, acid tartrate of potash,* other vegetable acids, etc.

Raisins are contained in Tinctura Cardamomi Composita and Tinctura Sennæ.

ACTION AND USES.

Raisins are **demulcent,** refreshing and nutrient, but are employed in medicine chiefly as **sweetening** and flavouring agents.

ZYGOPHYLLACEÆ.

Guaiaci Lignum—GUAIACUM WOOD.—The wood of Guaiacum officinale. Imported from St. Domingo and Jamaica, and reduced by the turning lathe to the form of a coarse powder or small chips.

Guaiaci Lignum is an ingredient of Decoctum Sarsæ Compositum. (See *Sarsæ Radix*, page 354.)

Guaiaci Resina—GUAIACUM RESIN.—The resin of Guaiacum officinale. Obtained from the stem by natural exudation, by incisions, or by heat.

Characters.—In large masses of a brownish or greenish-brown colour; fractured surface resinous, translucent at the edges; with pleasant aromatic odour and burning taste. Insoluble in water; soluble in alcohol, ether, chloroform, and alkaline fluids. A solution in rectified spirit strikes a clear blue colour when applied to the inner surface of a paring of raw potato.

Substances resembling Guaiacum Resin: Myrrh, Scammony, Benzoin, Aloes, Resin, which have no green tinge.

Composition.—The chief constituent of guaiacum wood is the officinal *resin*, with a crystalline bitter colouring matter, gum, etc. The resin is itself composed of three resins, *guaiaconic acid*, $C_{19}H_{20}O_5$, 70 per cent.; *guaiac acid*, $C_6H_8O_3$, resembling benzoic acid; and *guaiaretic acid*, $C_{20}H_{26}O_4$, 10 per cent., with an indifferent resin.

Incompatibles.—Mineral acids, spirit of nitrous ether.

Dose.—10 to 30 gr.

Preparations.

1. **Mistura Guaiaci.**—Guaiacum Resin, 2; Sugar, 2; Gum Acacia, 1; Cinnamon water, 80. *Dose*, ½ to 2 fl.oz.
2. **Tinctura Guaiaci Ammoniata.**—1 in 5 of Aromatic Spirit of Ammonia. *Dose*, ½ to 1 fl.dr., with 1 drachm of mucilage or yolk of egg.
3. **Pilula Hydrargyri Subchloridi Composita.**—1 in 2½. (See *Hydrargyrum*, page 86.)

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Internally, guaiacum is a **local stimulant**, producing salivation, an acrid hot sensation in the throat, warmth in the epigastrium, increase of the movements and secretions of the stomach and bowels, and reflex stimulation of the heart. In large quantity it is a gastro-intestinal irritant, causing powerful vomiting and purging, and the attendant disturbances of the system generally.

Guaiacum powder frequently relieves sore throat, if given in 30-grain doses, to be placed on the tongue, and slowly swallowed every six hours. The tincture or non-officinal lozenge is less successful. Plummer's pill doubtless owes part of its mildly purgative effect to the guaiac resin it contains.

2. ACTION ON THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTION AND USES.

The further action of guaiacum physiologically is still obscure. Besides its **stimulant effect on the circulation** already mentioned, it appears to increase the secretions of the skin and kidney, and probably **stimulates the liver** and metabolism generally. In the form of the ammoniated tincture it is used in chronic gout and rheumatism, certainly with much success in some cases. As a constituent of Decoctum Sarsæ Compositum, not alone, it is given as an **alterative** in syphilis.

RUTACEÆ.

Buchu Folia—BUCHU LEAVES.—The dried leaves of: 1. Barosma betulina, *Bartling.* 2. Barosma crenulata, *Hooker.* 3. Barosma serratifolia, *Willd.* Imported from the Cape of Good Hope.

Characters.—Smooth, marked with pellucid dots at the indentations and apex; having a powerful odour and a warm camphoraceous taste. 1. About three-quarters of an inch long, coriaceous, obovate, with a recurved truncated apex and sharp cartilaginous spreading teeth. 2. About an inch long, oval-lanceolate, obtuse, minutely crenated, five-nerved. 3. From an inch to an inch and a half long, linear-lanceolate, tapering at each end, sharply and finely serrated, three-nerved.

Impurities.—Leaves of *Emplanum serrulatum* (for those of B. serratifolia); have no glands.

Substances resembling Buchu: Senna and Uva Ursi, which have entire leaves.

Composition.—Buchu contains a *volatile oil,* in the glands or "dots," of a yellowish-brown colour, and the source of the peculiar odour of the leaves; a camphor, *barosma camphor;* a crude oil; and other substances of less importance.

Dose.—20 to 40 gr.

Preparations.

1. **Infusum Buchu.**—1 in 20. *Dose,* 1 to 4 oz.
2. **Tinctura Buchu.**—1 in 8. *Dose,* 1 to 4 fl.dr.

ACTION AND USES.

The action and uses of buchu closely resemble those of pareira, to the description of which the student is referred. It is more frequently employed than pareira, its infusion constituting an excellent vehicle for saline diuretics.

Oleum Rutæ—OIL OF RUE.—The oil distilled from the fresh herb of Ruta graveolens.

Characters.—Colour pale yellow, odour disagreeable, taste bitter, acrid.

Composition.—Oil of rue is a mixture of various *volatile oils.*

Dose.—2 to 6 min.

ACTION AND USES.

The action of rue is the same as that of savin; but it is seldom employed as an **emmenagogue**. See *Sabinæ Cacumina*, page 351.

Cuspariæ Cortex—CUSPARIA BARK. ANGUSTURA BARK.—The bark of Galipea Cusparia. From tropical South America.

Characters.—In straight pieces, more or less incurved at the sides, from half a line to a line in thickness, pared away at the edges; epidermis mottled, brown, or yellowish-grey; inner surface yellowish-brown, flaky; breaks with a short fracture; the taste is bitter and slightly aromatic. The cut surface examined with a lens usually exhibits numerous white points or minute lines.

Impurity.—The bark of Strychnos Nux vomica ("false angustura bark"), which may be distinguished by its inner surface giving a blood-red colour with nitric acid, whilst true cusparia bark does not. Cusparia resembles Canella alba, but is darker and has pared edges.

Incompatibles.—Mineral acids; perchloride of iron, and other metallic salts.

Composition.—Cusparia contains a neutral crystalline bitter principle, *cusparin* or *angusturin*, a second bitter substance, an *aromatic oil*, but no tannin.

Dose.—10 to 40 gr.

Preparation.

Infusum Cuspariæ.—1 to 20. *Dose*, 1 to 2 fl.oz.

ACTION AND USES.

Cusparia belongs to the group of **aromatic bitters**, the action and uses of which are fully discussed under *Calumba* and *Caryophyllum.* Like other bitters, it has been credited with antipyretic and antiperiodic properties, and in its native place is used instead of cinchona for malarious diseases.

Pilocarpi Folia (*Not Officinal*).—The leaflets of Pilocarpus pennatifolius. Jaborandi. Imported from Brazil.

Characters.—Leaves dull green, large, pinnate, with 3 to 5 pairs of leaflets and a terminal one. Leaflets coriaceous, 4 to 6 inches long, oblong, lanceolate, emarginate, smooth or only slightly tomentose, and full of pellucid dots.

Impurities.—Leaves of species of piper; not pinnate.

Composition.—Jaborandi contains *pilocarpin*, a liquid colourless alkaloid, to which its chief effects are due. It is said to contain a second (isomeric) alkaloid, *jaborin*, closely resembling atropia in its action, and therefore antagonistic to pilocarpin.

Dose.—5 to 60 gr.

Non-officinal Preparations.

Extract, *Dose*, 2 to 10 gr. Fluid Extract, 1 in 1; *Dose*, 10 to 60 min. Infusion, 1 in 20; *Dose.* 1 to 2 fl. oz. And Tincture, 1 in 2; *Dose*, 5 to 20 min. Also Hydrochlorate and Nitrate of Pilocarpin: *Dose of either*, $\frac{1}{20}$ to $\frac{1}{2}$ gr. by the mouth, $\frac{1}{10}$ to $\frac{1}{3}$ gr. hypodermically. The last is most used.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Jaborandi applied to the conjunctiva causes contraction of the pupil, tension of the apparatus of accommodation and disturbance of vision. The effect commences in ten minutes, and lasts from $1\frac{1}{2}$ to 24 hours before finally disappearing. It is used in some cases of inflammation of the eye, such as iritis; in certain forms of blindness; and in paralysis of the muscles. (See *Physostigma*, page 230.)

Internally, in full doses, it is liable to cause nausea and vomiting.

2. ACTION ON THE BLOOD.

Pilocarpin enters the blood rapidly and passes thence into the tissues.

3. SPECIFIC ACTION AND USES.

The striking effects of jaborandi consist in **profuse salivation, perspiration, disturbances of vision,** and **circulatory depression,** which last for hours, and leave a sense of drowsiness and debility behind them. Salivation is due to stimulation of the terminal ends of the chorda tympani in the glands, as well as of its centre. The flow commences in about five minutes after a moderate dose, and lasts several hours. It increases with the dose. It is completely prevented or arrested by atropia.

Perspiration is referable to stimulation both of the sudoriparous nerves and the sweat centres. It follows quickly on the appearance of the salivation; is accompanied by flushing of the skin, and sometimes rigor; progresses from the head downwards; may be so profuse as to soak the bedclothes; and lasts several hours. The body weight necessarily falls, metabolism is stimulated, and a large quantity of urea is said to be excreted by the skin. Atropia arrests this diaphoresis. The milk is doubtfully increased. The hair grows more actively under a course of jaborandi. Bronchial and nasal secretions flow more freely; even the tears, cerumen, and alimentary secretions are somewhat increased; but not the bile. The amount of urine is moderately raised by small doses. The menses are not affected. The eye is affected specifically, as it is locally. Respiration is not modified directly by pilocarpin. At first the heart and pulse are accelerated, but they are afterwards slowed and weakened; the blood pressure falls temporarily, then rises, and finally falls. Part of these effects are due to the action of the drug on the vagus in the heart, and can be arrested by atropia; part seem referable to the ganglia. The temperature rises before, and falls during, the sweating.

Pilocarpin has been tried in every kind of disease, but is now chiefly given as being a powerful and rapid diaphoretic. In renal dropsy, especially with uræmia, it may be of much service, eliminating a quantity of urea; also in effusions into the pleura and peritoneum; rarely in cardiac dropsy, since in this and every class of case it cannot be safely used if the heart be already weak. It has also been given in syphilis, and in a variety of uterine conditions, with various results. Bronchial catarrh, asthma, and pertussis are all relieved by the flux which it establishes. Small doses relieve the thirst of chronic Bright's disease. In certain dry skin diseases, and certainly in alopecia (baldness), it may answer well. Very conflicting reports have been published of its value in diphtheria, where it is said to loosen or detach the false membrane.

SIMARUBACEÆ.

Quassiæ Lignum—QUASSIA WOOD.—The wood of Picræna excelsa. From Jamaica.

Characters.—Billets varying in size, seldom thicker than the thigh. Wood dense, tough, yellowish white, intensely and purely bitter. Also chips of the same.

Substance resembling quassia: Sassafras, which is aromatic, and not bitter.

Composition.—The active principle of quassia is *quassin*, $C_{10}H_{12}O_3$, a white crystalline, neutral bitter principle. Quassia contains no tannin.

Preparations.

1. **Extractum Quassiæ.**—Aqueous. 48 in 1. *Dose*, 3 to 5 gr.
2. **Infusum Quassiæ.**—1 in 80 of *cold* water. *Dose*, 1 to 2 fl.oz.
3. **Tinctura Quassiæ.**—1 in 27. *Dose*, 1 to 2 fl.dr.

ACTION AND USES.

Quassia is a pure or **simple bitter**, and possesses the various properties fully described under *Calumbæ Radix*. It is very extensively used. The special points to be noted respecting it are: (1) that its preparations contain no tannin, and may be combined with salts of iron; (2) that it is entirely devoid of flavour, and intensely bitter, *i.e.* less agreeable than gentian and chiretta; and (3) that the infusion is an excellent anthelmintic enema.

CELASTRACEÆ.

Euonymus—WAHOO. (*Not Officinal.*)—The bark of Euonymus atropurpureus.

Characters.—Quilled or curved pieces; ash-grey with blackish patches without; whitish within; nearly inodorous; sweetish, somewhat bitter, and acrid.

Composition.—Euonymus contains *euonymin*, an uncrystallisable intensely bitter principle, various *resins*, and a *fixed oil.*

Non-officinal Preparations.

Extractum Euonymi (U. S. P).—*Dose*, 1 to 5 gr.
Euonymin.—An eclectic preparation, consisting of the resins and fixed oil. *Dose*, 1 to 5 gr.

ACTION AND USES.

Euonymin is an **hepatic stimulant, direct cholagogue, and mild cathartic**; the latter effect being but little marked unless other purgatives be combined. It is used in constipation and hepatic derangements.

RHAMNACEÆ.

Rhamni Succus—BUCKTHORN JUICE.—The recently expressed juice of the ripe berries of common Buckthorn, Rhamnus catharticus, a native of Britain.

Characters.—Deep red by reflected, green by transmitted, light.

Composition.—Buckthorn juice contains an active principle, *rhamnicin*, probably identical with cathartic acid, the purgative glucoside of senna and rhubarb.

Preparation.

Syrupus Rhamni.—*Dose*, 1 fl.dr.

ACTION AND USES.

Buckthorn is an active **cathartic**, naturally resembling senna and rhubarb. It is very seldom employed.

Rhamnus Frangula. (*Not Officinal.*)—The bark of the Rhamnus frangula, or Black Alder. Imported from Holland.

Characters.—Quills half a line thick, with a warty greyish-brown exterior; nearly inodorous; taste sweetish bitter.

Composition.—Black Alder contains an active crystalline principle, *emodin*, also found in Rheum (*see* page 317).

Non-officinal Preparations.

A Fluid Extract, and Lozenges.
Dose.—1 to 4 fl.dr. of the former.

ACTION AND USES.

Rhamnus frangula is a certain and pleasant **aperient**, without griping or severe cathartic action, used in chronic constipation, and especially suitable for children.

Rhamnus Purshiana. (*Not Officinal.*)—The bark of Cascara sagrada, or Rhamnus purshiana. From the North Pacific coast.

Composition.—A crystalline and various resinoid bodies have been obtained from cascara, which requires to be further investigated.

Non-officinal Preparations.

A Fluid Extract, and a Cordial.

ACTION AND USES.

Cascara sagrada is a **tonic** and **stomachic** in small doses, **aperient** in large doses, and cathartic if freely given. It is useful in the same class of cases as the Rhamnus frangula.

ANACARDIACEÆ.

Mastiche—MASTICH.—A resinous exudation obtained by incision from the stem of Pistacia lentiscus. Produced in the island of Scio.

Characters.—Small irregular yellowish tears, brittle, becoming soft and ductile when chewed, having a faint agreeable odour.

Substances resembling mastich : Acacia, ammoniacum, galbanum, which are larger, rougher, and more opaque.

Composition.—Mastich consists of 80 or 90 per cent. of a resin, *mastichic acid*, soluble in alcohol; of a smaller quantity of another resin, *masticin*, soluble in ether, but insoluble in alcohol; and of a trace of volatile oil.

ACTION AND USES.

Mastich was formerly used much like other oleo-resins, but its application is now confined to dentistry, where it is employed as a **temporary stopping for carious teeth.** A solution in ether or collodion is applied on cotton wool with oil of cloves or cinnamon, and remains as a firm plug by evaporation of the solvent.

AMYRIDACEÆ.

Myrrha—MYRRH.—A gum-resinous exudation from the stem of Balsamodendron myrrha. Collected in Arabia Felix and Abyssinia.

Characters.—In irregular-shaped tears or masses varying much in size, somewhat translucent, of a reddish-yellow or reddish-brown colour; fractured surface irregular and somewhat oily; odour agreeable and aromatic; taste acrid and bitter.

Composition.—Myrrh contains about 2 per cent. of an oxygenated *æthereal oil*, $C_{10}H_{11}O$, *myrrhol;* a *resin*, *myrrhin*, 35 per cent.; and *gum* 60 per cent. Myrrh forms a milky-white emulsion with water, the resin being suspended by the gum in solution

Impurities.—Every variety of resins and gum-resins: detected by appearance, smell, and taste.

Preparations.

1. **Pilula Aloes et Myrrhæ.**—1 in 6. (See *Aloe Socotrina*, page 357.)
2. **Tinctura Myrrhæ.**—1 in 8. *Dose*, ½ to 1 fl.dr.

Myrrh is also contained in Decoctum Aloes Compositum, Mistura Ferri Composita, Pilula Assafœtida Composita, and Pilula Rhei Composita.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Myrrh is a **stimulant and disinfectant** like other oleo-resins, and is sometimes used as a dressing for ulcers.

Internally.—It exerts a similar effect upon the mouth, throat, stomach, and bowels. It is much employed as a wash in spongy gums and ulcerated mouth; as a gargle in relaxed throat; and as a **stomachic** and adjuvant of purgatives in dyspepsia, anæmia, and constipation.

2. ACTION ON THE BLOOD AND ITS USES.

Myrrh appears to **increase the number of leucocytes** in the blood; and this fact may in part account for its value along with iron in anæmia.

3. SPECIFIC ACTION.

Nothing definite is known on this subject.

4. REMOTE LOCAL ACTION AND USES.

Like the oleo-resins (see *Terebinthinæ Oleum*) myrrh appears to be excreted by the mucous membranes, especially of the genito-urinary and respiratory tracts, and stimulates them during its passage. It is thus an **uterine stimulant and emmenagogue,** and is extensively given along with aloes or iron in the amenorrhœa of girls. As a **stimulant and disinfectant expectorant** it is much less used now than formerly in chronic bronchitis.

Elemi—Elemi.—A concrete resinous exudation, the botanical source of which is undetermined, but is probably Canarium commune. Chiefly imported from Manilla.

Characters.—A soft unctuous adhesive mass, becoming harder and more resinous by age; of a yellowish-white colour;

with a rather fragrant fennel-like odour; almost entirely soluble in rectified spirit.

Substances resembling Elemi: Assafœtida, Galbanum, Ammoniacum, known by smell.

Composition.—Elemi is a mixture of a turpentine and several resinous bodies.

Preparation.

Unguentum Elemi.—1 in 5.

ACTION AND USES.

Elemi acts much like resin of turpentine, and is employed in the ointment as a **stimulant and disinfectant** to sores and issues.

LEGUMINOSÆ.

Tragacantha—TRAGACANTH.—A gummy exudation from the stems of Astragalus verus, and possibly other species. Collected in Asia Minor.

Characters.—White or yellowish, in broad shell-like slightly curved plates, tough and elastic, but rendered more pulverisable by a heat of 120° Fahr. Very sparingly soluble in cold water; but swelling into a gelatinous mass, which is tinged violet by tincture of iodine. After maceration in cold water, the fluid portion is not precipitated by rectified spirit.

Impurities.—Other gums, and white lead.

Composition.—Tragacanth consists of two gums: *bassorin*, 33 per cent., comparatively insoluble in water, $C_{12}H_{20}O_{10}$, and unfermentable; and a gum nearly identical with the *arabin* of acacia (but precipitated by acetate of lead), 53 per cent., soluble in water. It also contains a little starch.

Preparations.

1. **Mucilago Tragacanthæ.**—1 in 80. *Dose*, 1 fl.oz. or more.
2. **Pulvis Tragacanthæ Compositus.**—Tragacanth, 1; Gum Acacia, 1; Starch, 1; Sugar, 3. *Dose*, 10 to 60 gr.

Tragacanth is also contained in Pulvis Opii Compositus.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Internally, tragacanth is **demulcent.** The mucilage may be used as a vehicle for active substances in linctuses for pharyngeal cough. Tragacanth is partly converted into sugar by the stomach; in large quantities it causes indigestion. It is chiefly employed to suspend resins and heavy powders, such as bismuth, the simple gum being preferable to the compound powder, because not fermentable.

2. ACTION ON THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTION.

Tragacanth, like other gums, enters the blood and tissues, partly unchanged, partly as sugar and other products, and has a nutritive effect of comparatively low value. It is not used for this purpose. A remote demulcent effect on the urinary organs is probably imaginary only.

Glycyrrhizæ Radix—LIQUORICE ROOT.—The root or underground stem, fresh and dried, of Glycyrrhiza glabra. Cultivated in England.

Characters.—In long cylindrical branched pieces, an inch or less in diameter, tough and pliable; of a greyish-brown colour externally, yellow internally; without odour, of a sweet mucilaginous and slightly acrid taste. Digested with water, it yields a solution which gives a precipitate with diluted sulphuric acid.

Substances resembling Liquorice Root: Pyrethrum and Taraxacum, which are not sweet.

Composition.—Liquorice root contains *grape-sugar*, *glycyrrhizin*, *starch*, *resin*, *asparagin*, and *malic acid*. Glycyrrhizin is a yellow amorphous glucoside, $C_{24}H_{36}O_9$, with a strong bitter-sweet taste and acid reaction, yielding glucose and a very bitter substance, *glycyrretin*.

Preparations.

1. **Extractum Glycyrrhizæ.**—Aqueous. *Dose*, ½ to 1 dr.
2. **Extractum Glycyrrhizæ Liquidum.**—Made as above with spirit. 2 fl. oz. = 1 oz. of solid extract. *Dose*, 1 fl. dr.
3. **Pulvis Glycyrrhizæ Compositus.**—1, with 1 of Senna and 3 of Sugar. *Dose*, 30 to 60 gr.

Non-officinal Preparation.

Pulvis Liquiritiæ Compositus (Ph. Germ. and Russ.).—1, with 1 of Senna, ½ of Sulphur, ½ of Fennel, and 3 of Sugar. *Dose*, a teaspoonful.

Liquorice or its preparations are contained in many preparations throughout the Pharmacopœia. It especially covers the taste of senna, chloride of ammonium, senega, hyoscyamus, turpentine, and bitter sulphates. The powdered root is a useful basis for pills.

ACTION AND USES.

Liquorice is chiefly used for the **pharmaceutical purposes** just indicated. It has a pleasant taste and flavour, and increases the flow of saliva and mucus when slowly chewed or sucked, the increased secretions acting as emollients to the throat. Liquorice is therefore a popular **demulcent**, much used to relieve sore throat and coughs.

Scoparii Cacumina—BROOM TOPS.—The fresh and dried tops of Sarothamnus Scoparius. From indigenous plants.

Characters.—Straight angular dark-green smooth tough twigs, of a bitter nauseous taste, and of a peculiar odour when bruised.

Composition.—Scoparium contains two active principles, *scoparin* and *spartein*, besides other constituents. Scoparin $C_{21}H_{22}O_{10}$, is a yellow crystalline neutral body, said by some to be a diuretic, by others not so. Spartein, $C_{15}H_{26}N_2$, is a volatile oily-looking liquid alkaloid, allied in appearance, composition, and physiological action to conia. See *Conii Fructus*, page 250.

Preparations.

1. **Decoctum Scoparii.**—1 *dried* in 20. *Dose*, 2 to 4 fl.oz.
2. **Succus Scoparii.**—3 of juice of *fresh* tops to 1 of spirit. *Dose*, 1 to 2 fl.dr.

ACTION AND USES.

Broom has a **bitter stomachic** and somewhat **astringent** action in moderate doses, but is not used on this account. Its further effect on the system is still obscure, the only fact definitely known being that it frequently produces free diuresis. It is believed that the active principles of the plant, either or both, pass through the blood and tissues, and stimulate the secreting substance of the kidneys during the process of excretion. Broom is therefore extensively used in this country as a **diuretic** in dropsy, especially cardiac dropsy, but is almost invariably combined with other drugs of the same class, such as digitalis, acetate of potash, etc. It should be avoided in acute venal dropsy.

Pterocarpi Lignum—RED SANDAL WOOD.—The wood of Pterocarpus santalinus. From Ceylon.

Characters.—Dense heavy billets, outwardly dark brown, internally variegated with dark and lighter red rings, if cut transversely. Powder blood-red, of a faint peculiar odour, and an obscurely astringent taste. Also chips of the same.

Substances resembling Sandal Wood: Logwood, less dense.

Composition.—Red sandal wood contains a blood-red crystalline principle, *santalic acid*, or *santalin*, insoluble in water.

Red Sandal Wood is contained in Tinctura Lavandulæ Composita.

USE.

Red sandal wood is used only to **give colour** to the Compound Tincture of Lavender.

Kino—KINO.—The inspissated juice obtained from incisions made in the trunk of Pterocarpus Marsupium. Imported from Malabar.

Characters.—In small angular brittle glistening reddish-black fragments, translucent and ruby-red on the edges, inodorous, very astringent. When chewed it tinges the saliva blood-red.

Composition.—Kino contains 75 per cent. of *kino-tannic acid*, $C_{18}H_{18}O_8$, giving a greenish precipitate with persalts of iron; *brenzcatechin*, a derivate of catechin (see *Catechu Pallidum*, page 270); and *kino-red*, formed from kino-tannic acid by oxydation.

Dose.—10 to 30 gr.

Preparations.

1. **Pulvis Kino Compositus.**—Kino, 15; opium, 1; cinnamon, 4 (1 of opium in 20). *Dose*, 5 to 20 gr.
2. **Tinctura Kino.**—1 to 10. *Dose*, $\frac{1}{2}$ to 2 fl.dr.

Kino is also a constituent of Pulvis Catechu Compositus, 1 in 5.

ACTION AND USES.

Kino closely resembles tannic acid in its action, and may be used for the same purposes. (See page 337.) It is chiefly employed in the form of **astringent** gargles, and as a constituent of mixtures for diarrhœa.

Balsamum Peruvianum—BALSAM OF PERU.—A balsam obtained from Myroxylon Pereiræ. It exudes from the trunk of the tree after the bark has been scorched and removed. From Salvador in Central America.

Characters.—A reddish-brown or nearly black liquid, translucent in thin films; having the consistence of syrup, a balsamic odour, and an acrid slightly bitter taste; soluble in five parts of rectified spirit. Undergoes no diminution in volume when mixed with water.

Impurity.—Resin, soluble in bisulphide of carbon.

Composition.—Balsam of Peru is a complex substance. The greater part consist of (1) the *volatile oil of Peruvian balsam*, which is itself composed of *cinnamin* (or *cinnamate of benzyl-æther*), $C_{16}H_{14}O_2$; *styracin* (or *cinnamate of cinnamic-æther*), $C_{18}H_{16}O_2$; *peruvin* (or benzyl-alcohol), C_7H_8O; *benzoate of benzyl æther;* (2) *cinnamic* and *benzoic acids* in small quantities; and (3) a mixture of *resins*, probably hydrates of cinnamin. See *Styrax.*

Dose.—10 to 15 minims, made into an emulsion with mucilage or yolk of egg.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Balsam of Peru possesses the properties of its several constituents—benzoic acid and its allies and resins, being an **antiseptic and disinfectant, a vascular and nutritive stimulant, and a nervine sedative.** (See *Terebinthinæ Oleum* for a full account, page 344.) Balsams have been used from time immemorial as applications to wounds and sores, but are now almost entirely displaced by simpler dressings, such as carbolic acid and boracic acid. They are still used, however, to cleanse bed-sores. A more important application of Peruvian balsam is in certain diseases of the skin, namely, (1) in some chronic inflammatory affections (eczema); (2) to **relieve itching**, prurigo, urticaria, etc., 1 in 8 of vaselin; (3) in scabies, for which it is the best of all remedies, **killing the acarus**, relieving the itching and inflammation, and disinfecting the parts. The skin should be thoroughly rubbed with it (1 drachm for the whole body) on two or more occasions, a warm bath being taken before and after.

Internally.—Balsam of Peru has a mild carminative effect on the stomach and bowels, like volatile oils.

2. ACTION ON THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTION AND USES.

The important changes undergone in the blood and tissues by benzoic and cinnamic acids, and the excretion of these and of aromatic oils by the mucous membranes, kidneys, and skin, are fully discussed under *Benzoin*, *Styrax*, and *Terebinthinæ Oleum.* The constituents of Peruvian balsam appear chiefly to affect the respiratory organs; and it may therefore be added to cough mixtures as an agreeable **stimulant and disinfectant expectorant** in chronic bronchitis.

Balsamum Tolutanum—BALSAM OF TOLU.—A balsam obtained from Myroxylon Toluifera. It exudes from the trunk of the tree after incisions have been made into the bark. From New Granada.

Characters.—A reddish-yellow soft and tenacious solid, becoming hard by keeping, with a fragrant balsamic odour; soluble in rectified spirit.

Composition.—Balsam of Tolu contains a *turpentine* $C_{10}H_{16}$, *benzoic and cinnamic acids*, and various *resins*.

Dose.—10 to 20 gr., as an emulsion with mucilage and sugar.

Preparations.

1. **Syrupus Tolutanus.**—1 in 29. *Dose*, 1 to 2 fl. dr.
2. **Tinctura Tolutana.**—1 in 8. *Dose*, 15 to 30 min.

Balsam of Tolu is also a constituent of Tinctura Benzoini Composita.

ACTION AND USES.

These are the **same as those of Peruvian balsam,** but tolu is used internally only, and chiefly as a pleasant ingredient of cough mixtures.

Physostigmatis Faba—CALABAR BEAN.—The seed of Physostigma venenosum. Western Africa.

Characters.—About the size of a very large horse-bean, with a very firm, hard, brittle shining integument of a brownish-red, pale chocolate, or ash-grey colour. Irregularly kidney-shaped, with two flat sides, and a furrow running longitudinally along its convex margin, ending in an aperture near one end of the seed. Within the shell is a kernel consisting of two cotyledons, weighing on an average about 46 grains, hard, white, and pulverisable, of a taste like that of the ordinary edible leguminous seeds, without bitterness, acrimony, or aromatic flavour. It yields its virtues to alcohol, and imperfectly to water.

Composition.—Besides the ordinary constituents of beans, the seed of physostigma contains an active principle, *physostigmin* or *eserin*, $C_{15}H_{21}N_3O_2$, an alkaloid, combining with acids, and variously obtained as colourless crystals, or an amorphous or syrupy body.

Dose, in powder.—1 to 4 gr.

Preparation.

Extractum Physostigmatis.—Spirituous. 45 in 1. *Dose*, $\frac{1}{16}$ to $\frac{1}{4}$ gr.

1. IMMEDIATE LOCAL ACTION AND USES.

Extract of physostigma or preparations of eserine are readily absorbed by the conjunctiva, and produce the specific contraction of the pupil to be presently noticed.

Taken by the mouth, calabar bean in moderate doses sometimes causes sickness and colic, and in larger doses diarrhœa, all from increased and irregular peristalsis, apparently of local origin. The extract is therefore occasionally used in habitual constipation.

2. ACTION IN THE BLOOD.

Eserin enters the blood unchanged, and passes thence into the tissues.

3. SPECIFIC ACTION AND USES.

Eserin is found in all the organs. Along with the gastro-intestinal symptoms first described, moderate doses of the bean give rise to a sense of weakness, faintness, and shortness of breath; larger doses to an aggravation of the same symptoms, with contraction of the pupil, frontal headache, salivation, diaphoresis, slowing and weakening of the pulse. These are short of truly poisonous effects.

On analysis it is found that consciousness is not lost, though impaired by large doses, showing comparative freedom of the *convolutions*. The *cord* is the part principally affected by calabar bean, the chief symptoms being of the nature of motor paralysis from **depression of the anterior cornua**, and thus of reflex irritability also. The respiratory muscles necessarily fail from this cause. The posterior cornua (sensory portions) of the cord are paralysed to a degree, so that sensibility is diminished in the limbs. The *motor nerves* and *muscles* are but slightly affected directly. Occasional twitchings occur, whether direct or spinal in origin. The *sensory nerves* are not directly influenced. The *medulla* is decidedly affected by physostigma. Thus the **respiratory centre**, after brief (probably reflex) stimulation, is **depressed**, and death occurs chiefly by asphyxia. The cardiac centre is first stimulated, so that the heart beats more powerfully and less frequently; but at last, or after large doses, depression ensues. Therewith the intracardiac branches of the vagus are probably stimulated at first, and the ganglia paralysed at last. The blood pressure rises with the increased cardiac action, and falls later on. Whether there is any direct action of eserin on the vaso-motor apparatus is unsettled.

Contraction of the pupil and spasm of accommodation are striking and highly important effects of eserin, whether it be given internally or applied locally. Both phenomena are due **to irritation of the fibres of the third nerve**, and not to central disturbance as in the contraction caused by opium, or to paralysis of the sympathetic. These effects are accompanied by fall of the intraocular tension, and can be removed by atropia. The salivary secretion is increased through the centre of the chorda, but ceases after large doses from arrest of the circulation in the glands.

The specific *uses* of calabar bean depend on its action on the cord and the eye. It has been frequently given in tetanus, and other convulsive diseases referable to irritation or disease of the spinal centres, and apparently with success, although many of these cases recover spontaneously, and others resist the eserin. The alkaloid should be given subcutaneously in doses of gr. $\frac{1}{60}$ to $\frac{1}{12}$ in solution; or gr. $\frac{1}{3}$ of the extract may be given subcutaneously, or gr. 1 by the mouth, repeated in two hours, and followed by doses of gr. $\frac{1}{16}$ to $\frac{1}{4}$ every few hours. For the convulsions of strychnia poisoning calabar bean is of little or no use. Neither is it of much real service in the treatment of poisoning by atropia or chloral, as was once expected.

In diseases of the eye eserin is now much used. A drop of a solution of the sulphate (2 gr. to 1 ounce of water) is applied locally to diminish intraocular pressure in glaucoma, perforating keratitis, etc.; in paralysis of the iris and ciliary muscle, *e.g.* after diphtheria ($\frac{1}{2}$ gr. to 1 ounce); to counteract the effects of belladonna; or to diminish the entrance of light in painful diseases of the eye, photophobia, etc.

4. REMOTE LOCAL ACTION.

Eserin is excreted by the liver and salivary glands, but has never been found in the urine.

Araroba — GOA POWDER. — A concretion from clefts in the stem of Andira Araroba (Angeliun Amargosa) imported from Brazil chiefly into India. (*Not officinal.*)

Characters.—A powder or in small pieces of a light yellow colour, becoming pale-brown by exposure; mixed with small pieces of wood.

Composition.—Goa powder contains 80 per cent. of *chrysarobin*, $C_{30}H_{26}O_7$, which is converted into *chrysophanic acid*, by the process presently to be given.

From Goa Powder is prepared:

Acidum Chrysophanicum.—Chrysophanic acid $C_{41}H_{10}O_4$. Made by exhausting Goa powder with hot Benzol, filtering, allowing Chrysarobin to crystallise out, dissolving this in strong Potash, and decomposing with a mineral acid. It may also be obtained from Rhubarb. See *Rhei Radix*, page 318.

Characters.—A dull orange-yellow powder, or shining yellow needles, odourless, with an acrid taste; insoluble in water, and spirit; soluble in hot benzol, oils, and vaseline.

Dose.—$\frac{1}{10}$ to 2 gr.

Preparation.

Unguentum Acidi Chrysophanici.—*Unguentum Chrysarobini* (U.S.P.). 1 in 10 of benzoated lard.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Goa powder or chrysophanic acid **destroys low vegetable organisms** in connection with the **skin**, stains it yellow, and **stimulates** it so much as to produce in some instances serious constitutional disturbance. It is a successful application in some forms of ringworm, and in scaly diseases of the skin, especially psoriasis.

Internally.—Chrysophanic acid is apt to cause vomiting and purging.

2. ACTION ON THE BLOOD; SPECIFIC ACTION; AND REMOTE LOCAL ACTION AND USES.

Chrysophanic acid has been given with various degrees of success in psoriasis, apparently by a remote local action on the skin.

Senna Alexandrina—ALEXANDRIAN SENNA.—The leaflets of Cassia lanceolata and Cassia obovata, imported from Alexandria; carefully freed from the flowers, pods, and leafstocks of the same, and from the leaves, flowers, and fruit of Solenostemma Argel.

Characters and Tests.—Lanceolate or obovate leaflets, about an inch long, unequally oblique at the base, brittle, greyish-green, of a faint peculiar odour, and mucilaginous sweetish nauseous taste. The unequally oblique base, and freedom from bitterness, distinguish the senna from the argel leaves, which, moreover, are thicker and stiffer.

Impurities; and *substances resembling Senna:* Solenostemma Argel, Uva Ursi, and Barosma, all equal at the base.

Senna Indica—TINNIVELLY SENNA.—The leaflets of Cassia elongata. From plants cultivated in Southern India.

Characters.—About two inches long, lanceolate, acute, unequally oblique at the base, flexible, entire, green, without any admixture; odour and taste those of Alexandrian Senna.

Composition.—Senna contains an active principle, *cathartic acid;* a colouring matter closely allied to *chrysophanic acid;* peculiar unfermentable sugar, *catharto mannite;* other obscure glucosides, *sennapicrin* and *sennacrol;* and various vegetable salts. Cathartic acid, a highly important body, is an amorphous glucoside, $C_{180}H_{192}N_2SO_{82}$, which forms salts with bases, and can be broken up in into glucose and cathartogenic acid.

Dose.—10 to 30 gr. in powder.

Preparations of either kind of Senna:

1. **Confectio Sennæ.**—1 in 11 with Coriander, Figs, Tamarinds, Cassia Pulp, Prunes, Extract of Liquorice, Sugar and Water. *Dose,* 60 to 120 gr.
2. **Infusum Sennæ.**—1 in 10. *Dose,* 1 to 2 fl.oz.

   From Infusum Sennæ is prepared:

   a. **Mistura Sennæ Composita.**—Infusion of Senna, 14; Tincture of Senna, 2½; Sulphate of Magnesia, 4; Extract of Liquorice, ½; Compound Tincture of Cardamoms, 1¼. *Dose,* 1 to 1½ fl.oz.

3. **Syrupus Sennæ.**—1 in 2. *Dose,* 1 to 4 fl.dr.
4. **Tinctura Sennæ.**—1 in 8. *Dose,* 1 to 4 fl.dr.

Senna is also the most important ingredient in Pulvis Glycyrrhizæ Compositum. 2 in 10. See *Glycyrrhizæ Radix,* page 224.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Given *internally*, senna **stimulates the muscular coat of the intestine,** apparently by local reflex action, originating in the mucous surface of the bowel itself; and produces brisk peristaltic movements and **purgation** within four or five hours. The colon is chiefly stimulated, hurrying downwards the fluid contents received from the ileum, which appear as very thin copious yellow stools, with excess of soda salts and digestive products, but no special increase of bile. Full doses cause repeated evacuation and griping, but no inflammation of the mucous surface. The pelvic structures may, however, become hyperæmic, leading to hæmorrhoids and the appearance of the menses. Constipation does not follow the use of senna.

Senna is never given alone, but always with a carminative to prevent griping, and frequently with other purgatives, as in the compound mixture. It is one of the most useful of purgatives. It is very extensively prescribed to complete the effect of mercurial and other duodenal purgatives, given several hours before. It affords at once a rapid and a safe purge at the commencement of febrile attacks in children, in local inflammations, and in cerebral congestion. As an habitual laxative in the form of Pulvis Glycyrrhizæ Compositus, senna is most valuable as a simple stimulant of the muscular coat, which neither loses its effect by use, nor produces subsequent constipation. Combined with bitter and other stomachics, it is useful in atonic dyspepsia, its laxative effect being increased by acids but diminished by alkalies.

ACTION IN THE BLOOD, SPECIFIC AND REMOTE LOCAL ACTION.

Cathartic acid and chrysophanic acid enter the blood, pass through the tissues, and are excreted by the kidneys and mammary gland; the cathartic acid purging infants at the breast, the chrysophanic acid staining the urine yellow. Senna purges animals when injected into the veins.

Hæmatoxyli Lignum—Logwood.—The sliced heart-wood of Hæmatoxylum Campechianum. Imported from Campeachy, Honduras, and Jamaica.

Characters.—The logs are externally of a dark colour, internally they are reddish-brown. The chips have a feeble agreeable odour, and a sweetish taste. A small portion chewed imparts to the saliva a dark pink colour.

Composition.—Logwood contains *tannic acid*, and a peculiar colouring principle, *hæmatoxylin*, $C_{10}H_{14}O_6$, occurring in colourless crystals, which become red on exposure to light, the solutions undergoing various changes of colour with acids and alkalies, and coagulating gelatine. The decoction precipitates perchloride of iron violet blue, acetate of lead and other metallic salts a beautiful blue. Other less important substances occur in logwood.

Incompatibles.—Mineral acids, metallic salts, lime-water, and tartar emetic.

Preparations.

1. **Decoctum Hæmatoxyli.**—1 in 20. *Dose*, 1 to 2 fl.oz.
2. **Extractum Hæmatoxyli.**—Aqueous. *Dose*, 10 to 30 gr.

ACTION AND USES.

Hæmatoxylum possesses the **astringent** action of tannic acid, and may be used in the same class of cases. See *Galla.*

Cassiæ Pulpa—CASSIA PULP.—The pulp obtained from the pods of the Purging Cassia, Cassia Fistula. Imported from the East Indies, or recently extracted from pods imported from the East or West Indies.

Characters of the pods.—Cylindrical, a foot or more in length, slightly curved, woody, indehiscent, black, rounded, divided by septa into cells, each containing a seed and viscid pulp. *Of the pulp:* blackish-brown, viscid, sweetish disagreeable taste, and somewhat sickly in odour, usually containing the seeds and dissepiments.

Composition.—Cassia pulp contains sugar, pectin, mucilage, and a purgative principle supposed to be allied to cathartic acid. See *Senna.*

Cassia Pulp is contained in Confectio Sennæ, about 1 in 8.

ACTION AND USES.

Cassia pulp is a **laxative**, given only as an ingredient of Confectio Sennæ.

Tamarindus—TAMARIND.—The preserved pulp of the fruit of Tamarindus indica. Imported from the West Indies.

Characters and Test.—A brown sweetish subacid pulp preserved in sugar, containing strong fibres and brown shining seeds, each enclosed in a membranous coat.

Impurity.—Copper; a piece of bright iron left in contact with the pulp for an hour does not exhibit any deposit of copper.

Composition.—Tamarind contains sugar, gum, tartaric acid, acid tartrate of potash, citric, acetic, and various aromatic acids.

Tamarind is contained in Confectio Sennæ, about 1 in 8.

ACTION AND USES.

Tamarind acts as a pleasant acid **refrigerant and gentle laxative.** For the former purpose it is prepared either as an infusion or as tamarind whey (1 part of the pulp to 30 parts warm milk), which is also a mild purgative, like the Confectio Sennæ.

Copaiba—COPAIVA.—The oleo-resin obtained from incisions made in the trunk of Copaifera multijuga, and other species of Copaifera. Chiefly from the valley of the Amazon.

Characters and Tests.—About the consistence of olive oil, light yellow, transparent, with a peculiar odour, and an acrid aromatic nauseous taste. Perfectly soluble in an equal volume of benzol. Is not fluorescent.

Composition.—Copaiba consists of less than 50 per cent of the officinal *volatile oil*, and more than 50 per cent of *resin.* The oil of copaiva, isomeric with turpentine, $C_{10}H_{16}$, is colourless or pale yellow, with the odour and taste of copaiva. Resin of Copaiva, $C_{20}H_{30}O_2$, is a brownish resinous mass, consisting of a crystallisable resin, *copaivic acid*, the chief constituent of the oleoresin, and a non-crystallisable *viscid resin of copaiba*, amounting to 1½ per cent. The proportion of oil and resin varies much with the age and exposure of the copaiba.

Impurities.—Turpentine, detected by the odour on heating. Fixed oils, detected by a greasy ring round the resinous stain left by copaiva when heated on paper. Copaiva dissolves one-fourth its weight of carbonate of magnesia by the aid of heat, and remains transparent; not so the fixed oil. Gurjun balsam, which coagulates at 270°.

Dose.—½ to 1 fl.dr.

Preparation.

Oleum Copaibæ.—The oil distilled from Copaiba. *Dose*, 5 to 20 min., with mucilage or yolk of egg.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION.

Copaiva produces an acrid nauseous sensation in the mouth, warmth in the stomach, unpleasant eructations, and gastro-intestinal irritation like other oleo-resins. Large doses or the persistent use of the drug leads to dyspepsia, sickness, and diarrhœa; and it is contra-indicated in irritable states of the stomach and bowels.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION.

The active principles of copaiva are absorbed into the blood, and pass thence into the tissues. The action of copaiva on the organs and tissues generally is obscure.

3. REMOTE LOCAL ACTION AND USES.

The volatile oil of copaiba is excreted by the kidneys, bronchi, and skin, and the resin at least by the kidneys. All the secretions smell freely of the drug, and the neighbourhood of the patient is pervaded with a characteristic unpleasant odour. In thus passing through the eliminating organs, copaiva stimulates them, altering their secretions and the nutrition of their cells and vessels. The urine is passed more frequently, and usually in increased quantity; but it may be scanty, with albumen and blood, pain in the loins, and other symptoms of renal congestion. The albumen thus passed must be distinguished from the acid resin of copaiva which may be thrown down from the urine by nitric acid, and which is dissolved by heat or alcohol. Carried by the urine into the bladder and urethra, and possibly also excreted by the mucous membranes of the same parts, copaiva **produces along the whole genito-urinary tract a stimulant and disinfectant effect.** A similar influence is produced in the bronchi, and the mucous secretion is increased, and **expectoration reflexly excited.** The stimulation of the skin (and probably the primary gastro-intestinal irritation in part) may sometimes cause an eruption, the **"copaiba rash,"** not unlike that of measles.

The uses of copaiva depend entirely on its remote local effects, the immediate local effects only suggesting care in its administration. Its chief application is to the genito-urinary organs. The resin is given as a highly useful **diuretic** in hepatic and cardiac dropsy, but must be avoided in the dropsy attending Bright's disease. It is much to be preferred to the oleo-resin for this purpose. The latter is chiefly employed in inflammatory affections of the bladder and urethra, especially gonorrhœa, when the first acute symptoms have somewhat subsided. It is best combined with potash and cubebs. Naturally it is less useful in the vaginal gonorrhœa of women. Copaiba is now seldom used in bronchial affections, on account of the unpleasant effects attending it; but in hospital practice it will sometimes diminish and disinfect the profuse foul products of chronic bronchitis and bronchiectasis when other means have failed. It is occasionally given in skin diseases.

Acaciæ Gummi—GUM ACACIA.—A gummy exudation from the stems of one or more undetermined species of Acacia.

Characters and Tests.—In spheroidal tears, nearly colourless, and opaque from numerous minute cracks; or in fragments with shining surfaces; brittle; bland and mucilaginous in taste; insoluble in alcohol, but soluble in water.

Impurities.—Starch; detected by the iodine test. Gum resins; detected by smell and taste.

Incompatibles.—Alcohol and sulphuric acid, borax, persalts of iron, and subacetate of lead.

Composition.—Gum arabic consists chiefly of *arabic acid* or *arabin*, $C_{36}H_{66}O_{33}$, combined with calcium, magnesia, and potash, and 17 per cent. of water.

Preparations.

Mucilago Acaciæ.—Gum, 40; Water, 60. *Dose*, 1 to 4 fl.dr.

Gum Acacia is also contained in Mistura Cretæ, Mistura Guaiaci, Pulvis Amygdalæ Compositus, Pulvis Tragacanthæ Compositus, and in all Trochisci.

ACTION AND USES.

Acacia possesses very similar properties and physiological effects to those of tragacanth, and is employed for the same purposes. (See *Tragacantha.*) An objection to its pharmaceutical use is its liability to undergo fermentation, and cause indigestion, flatulence, and diarrhœa. Its principal application therapeutically is for cough in the form of lozenges and linctuses.

Indigo—C_8H_5NO. A blue pigment prepared from various species of Indigofera. From India.

Use.—Indigo is employed in chemical testing.

ROSACEÆ.

Rosæ Gallicæ Petala—RED ROSE PETALS.—The fresh and dried unexpanded petals of Rosa gallica. From plants cultivated in Britain.

Characters.—Colour fine purplish-red, retained after drying; taste bitterish, feebly acid, and astringent; odour roseate, developed by drying.

Composition. — Red-rose petals contain an *aromatic oil, tannic* and *gallic acids*, gum, colouring matters, salts, etc. *Oleum rosæ* exists in very small quantity; it consists of an aromatic oxygenated elœoptin, and an odourless solid rose-camphor.

Preparations.

1. **Confectio Rosæ Gallicæ.**—1 of *fresh* petals in 4. *Dose*, 30 to 60 gr.
2. **Infusum Rosæ Acidum.**—1 of *dried* petals in 40 of diluted sulphuric acid and water. *Dose*, 1 to 2 fl.oz.
3. **Syrupus Rosæ.**—1 of *dried* petals in 17¼. *Dose*, 1 to 2 fl.dr.

Rosæ Centifoliæ Petala — CABBAGE ROSE PETALS.—The fresh petals, fully expanded, of Rosa centifolia. From plants cultivated in Britain.

Characters.—Taste sweetish, bitter, and faintly astringent; odour roseate; both readily imparted to water.

Preparation.

Aqua Rosæ.—1 in 1 by distillation. *Dose*, 1 to 2 fl.oz.

ACTION AND USES.

The preparations of the red and the cabbage rose are chiefly used as pleasant **vehicles.** The acid infusion is an agreeable astringent.

Rosæ Caninæ Fructus—FRUIT OF THE DOG

Rose—Hips.—The ripe fruit of the Dog Rose, Rosa canina, and other indigenous allied species.

Characters.—An inch or more in length, ovate, scarlet, smooth, shining; taste sweet, subacid, pleasant.

Preparation.

Confectio Rosæ Caninæ.—1 in 3. *Dose*, 60 gr. or more.

Confectio Rosæ Caninæ is contained in Pilula Quiniæ.

ACTION AND USE.

The confection of hips forms a very useful **basis for pills.**

Composition.—Hips contain *malic* and *citric acids*, free and combined, *tannic acid, sugar*, and a trace of *volatile oil.*

Amygdala Dulcis—Sweet Almond.—The seed of the sweet almond tree, Amygdalus communis, *var.* dulcis. Cultivated about Malaga.

Characters.—Above an inch in length, lanceolate, acute, with a clear cinnamon-brown seed-coat, and a bland sweetish nutty-flavoured kernel. Does not evolve the odour of bitter almonds when bruised with water.

Impurity.—The bitter almond, which yields an odour of hydrocyanic acid when bruised with water.

Amygdala Amara—Bitter Almond.—The seed of the bitter almond tree, Amygdalus communis, *var.* amara. Brought chiefly from Mogadore.

Characters.—Resembles the sweet almond in appearance, but is rather broader and shorter; has a bitter taste, and when rubbed with a little water emits a characteristic odour.

Composition.—Both varieties of almond yield by expression about 50 per cent. of *fixed* oil, Oleum Amygdalæ, and albuminous substances, including *emulsin.* The bitter variety also yields, by distillation with water, a *volatile* oil, Oleum Amygdalæ Amara, Essential Oil of Almonds, not officinal.

This Essential Oil of Bitter Almonds, or "Oil of Bitter Almonds," although not officinal, must be carefully distinguished from the officinal fixed oil, Oleum Amygdalæ, inasmuch as in the crude form generally sold it is highly poisonous, from admixture with 4 to 8 per cent. of hydrocyanic acid. Bitter almonds contain neither the volatile oil nor hydrocyanic acid until moistened, but 2 to 3 per cent. of a body called *amygdalin*, $C_{20}H_{27}NO_{11}$, a crystalline glucoside, which, in the presence of water, and under the fermentive influence of the emulsin, breaks up into the volatile oil, hydrocyanic acid, and glucose: $C_{20}H_{27}NO_{11} + 2H_2O = C_7H_6O + HCN + 2C_6H_{12}O_6$. When purified by separation of the hydrocyanic acid, volatile oil of bitter almonds is not poisonous, consisting, as it does, of hydride of benzol (C_7H_5OH), with benzoic acid ($C_7H_6O_2$) as a product of oxydation by exposure, and other allied substances, and is used for flavouring sweets. Nitro-benzine, however, which is sometimes substituted for it, having a very similar flavour, is decidedly poisonous.

Preparations of the Sweet Almond.

1. **Oleum Amygdalæ.**—Almond Oil. The oil *expressed* from bitter and sweet almonds. Pale yellow, nearly inodorous or with a nutty odour, and a bland oleaginous taste. *Dose*, 2 to 4 fl.dr.

   Almond Oil is contained in Unguentum Cetacei, Unguentum Simplex (and its preparations), Unguentum Hydrargyri Oxidi Rubri, Unguentum Plumbi Subacetatis Compositum. It is used in preference to olive oil, as it makes a whiter ointment.

2. **Pulvis Amygdalæ Compositus.**—8 to 4 of Sugar, and 1 of Gum Acacia. *Dose*, 60 to 120 gr.

   Pulvis Amygdalæ is used in preparing :

   a. **Mistura Amygdalæ.**—1, with water, 8. *Dose*, 1 to 2 fl.oz.

ACTION AND USES.

The Sweet Almond is **demulcent and nutritive**, and has been ground into a flour for making cakes to be eaten by diabetic patients, instead of starchy food. The Compound Powder and Mixture are used only as vehicles for insoluble powders and demulcent cough medicines.

Almond oil has the same action, and is used for the same purposes, as olive oil, which, though less agreeable, is more generally employed as being cheaper. See *Oleum Olivæ*, p. 284.

Prunum—PRUNE.—The dried drupe of the Plum, Prunus domestica. From southern Europe.

Composition.—The prune contains *sugar*, *malic acid*, and a purgative principle.

Prune is contained in Confectio Sennæ, 1 in 12½.

ACTION AND USES.

The prune is **nutritive, demulcent, and slightly laxative,** It may be ordered as an article of diet in habitual constipation.

Laurocerasi Folia—CHERRY-LAUREL LEAVES.—The fresh leaves of Prunus Laurocerasus. The Common or Cherry Laurel.

Characters.—Ovate-lanceolate or elliptical, distantly toothed, furnished with glands at the base, smooth and shining, deep green, on strong short footstalks; emitting a ratafia odour when bruised.

Composition.—Cherry laurel leaves yield by distillation a variable amount of *hydrocyanic acid*, and a *volatile oil*, by a process of decomposition resembling that just described in the bitter almond. Neither emulsin nor ordinary amygdalin have, however, been demonstrated in the leaves, but a resinoid body, which yields with emulsin hydrocyanic acid, and is called "*amorphous amygdalin.*"

Preparation.

Aqua Laurocerasi.—1 in 1¼ by distillation. *Incompatibles*, metallic salts. *Dose*, 5 to 30 min.

ACTION AND USES.

Cherry-laurel water possesses the action of hydrocyanic acid, and is also a **flavouring** agent. The strength of the drug in this very powerful substance is so uncertain that **its use ought to be avoided.** See *Acidum Hydrocyanicum Dilutum.*

Cusso—KOUSSO.—The flowers and tops of Brayera anthelmintica. Collected in Abyssinia.

Characters.—Flowers small, reddish brown, on hairy stalks, outer limb of calyx five-parted, the segments oblong or oblong-lanceolate, reticulated, with a fragrant odour and a disagreeable acrid taste.

Composition.—Kousso contains a *volatile oil*, tannic acid, gum, sugar, and a neutral crystallisable active principle, *koussin*, or cossin, $C_{31}H_{38}O_{10}$.

Dose.—¼ to ½ oz.

Preparation.

Infusum Cusso.—¼ oz. in 4 fl.oz. boiling water for one dose; to be drunk without straining.

ACTION AND USES.

Taken in the large doses necessary, kousso is apt to cause nausea, vomiting, colic, and slight diarrhœa. Its principal action is as an **anthelmintic**, the tape-worms (Tænia solium, Tænia mediocanellata, and Bothryocephalus latus) being readily killed by it. It is used for this purpose only, and rarely in England. It may or may not require the assistance of a purgative to expel the dead worm. The powdered flowers, either in compressed masses or suspended in an aromatic water, are said to be much more active than the officinal infusion.

MYRTACEÆ.

Caryophyllum — CLOVES. — The dried unexpanded flower buds of Caryophyllus aromaticus. Cultivated in Penang, Bencoolen, and Amboyna.

Characters.—About six lines long, dark reddish-brown, plump and heavy, consisting of a nearly cylindrical body surmounted by four teeth and a globular head, with a strong fragrant odour, and a bitter spicy pungent taste. It emits oil when indented with the nail.

Composition.—Cloves contain 20 per cent. of the officinal *oil*, tannic acid, and gum. Oil of cloves consists of *eugenol* (eugenic acid), $C_{10}H_{12}O_2$, chemically resembling phenol (carbolic acid), and a turpentine. A crystalline body, *eugenin*, isomeric with eugenol, and a neutral body, *caryophyllin*, isomeric with camphor, can also be obtained from cloves.

Preparations.

1. **Oleum Caryophylli.**—Oil of cloves. The oil distilled in Britain from cloves. Colourless, when recent, becoming red-brown, with the odour and burning spicy taste of the clove. It is one of the few volatile oils heavier than water. *Dose*, 1 to 4 min.
2. **Infusum Caryophylli.**—1 in 40. *Dose*, 1 to 2 fl.oz.

Cloves and Oil of Cloves are also contained in several preparations of other drugs.

ACTION AND USES.

Cloves may be taken as the type of a great group of remedies, other members of which are orange, lemon, pimenta, cajuput, carui, dill, peppermint, and many more, which are met with in our systematic review of medicinal plants. This group is known as the **aromatic essential oils,** of complex and variable chemical composition, but consisting as a rule of terpenes, mixed with camphors, resins, fatty and other acids, and different vegetable constituents. They are closely allied, on the one hand, to phenol (carbolic acid) and benzoic acid, and on the other to still more complex vegetable products, the balsams and gum-resins. Instead of dislocating the various members of the group of aromatic oils from their proper botanical position to discuss them together, we will describe their action and uses once for all under the present head, it being understood that what is said of oil of cloves applies to the other substances, with insignificant qualifications.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, the essential oil of cloves and allied substances closely resemble turpentine in properties. Thus, whilst **preventing or arresting decomposition,** they redden and inflame the skin, and cause for a time smarting pain, which gives place to local anæsthesia. Oil of cloves and other officinal fragrant oils are too costly to be used externally, except to scent liniments; but the concrete "oils," or solid constituents of the oils, of peppermint, thyme, eucalyptus, myrtle, etc. (stearoptenes), are excellent **antiseptics, local anæsthetics, stimulants** and **counter-irritants** and turpentine and camphor are common applications for these purposes. Such aromatic substances might be used to disinfect foul wounds and ulcers, and promote healing; to hasten the removal of chronic inflammatory products by increasing the local blood-flow, and thus to reduce swelling in or under the skin, the periosteum, or the joints; to relieve neuralgic and rheumatic pains, such as sciatica and lumbago, by dulling the sensibility of the nerves; and to act reflexly on deeper parts, for instance, the lung or heart, when applied to the skin over them as counter-irritants.

Internally.—In the mouth the aromatic oils of cloves and its allies act much as they do on the skin. Besides being antiseptic, they dilate the local vessels (? directly), and thus increase the circulation, heat, and nutrition, and may even cause inflammation. They irritate the nerves, causing pain associated with a sense of burning; but depression quickly follows, and local anæsthesia. Oil of cloves is a valuable application in toothache from dental caries, acting at once as an anodyne and disinfectant. At the same time, the nerves of **taste** and **smell** (flavour) are powerfully **excited.** Several results, of the first importance in digestion, follow these local changes, namely : (1) reflex salivation; (2) reflex flow of mucus; (3) reflex hyperæmia of the gastric mucosa, a sense of hunger, and a flow of gastric juice; (4) stimulation of the appetite and increase of relish by the pleasing flavour; and (5) in a word, **increased desire for, enjoyment of, and digestion of food.**

Aromatic oils are accordingly used very extensively in cookery, where the proper use of them constitutes an important portion of the culinary art. Those of them which are also bitter, such as orange, are taken with wines and spirits as various "aromatic bitters," liqueurs, etc., to rouse or strengthen appetite and digestion before or during a meal. In pharmacy they are employed to correct the tastes of nauseous drugs; and therapeutically they are given in dyspepsia and debility along with most bitters to increase the saliva and gastric juice.

In the stomach, the effect of aromatics on the vessels and nerves is continued; and here it is generally described as **carminative.** Besides causing an increased flow of juice, by stimulation of the mouth, these substances are powerful **stomachics** in several ways. The vessels of the mucosa are dilated; the nerves of the same are first excited (causing a sense of heat in the epigastrium) and then soothed, thus relieving pain; the contents, if decomposing, as in dyspepsia, are partly disinfected. Their reflex influence is equally important. The muscular coat is stimulated, thus increasing the gastric movement, expelling flatulence, and relieving painful cramps, spasms, hiccup, and other forms of distress. Distant organs are also stimulated: the vigour of the heart increased, the blood pressure raised, and the spinal, medullary, and even cerebral centres temporarily excited, to the relief of low, hysterical, and "spasmodic" symptoms, very common in certain classes of females, as well as of more serious conditions, such as asthma, cardiac pain, and palpitation. Aromatics are thus **general stimulants** and **antispasmodics.**

In the intestines the aromatic oils may still be found partly unabsorbed, acting on the same structures as before, increasing the local functions, stimulating the intestinal movements, and expelling flatus. They thus relieve or prevent pain or spasm (colic), and provide us with valuable **correctives** of the griping tendencies of many purgatives. The constitution of the most important compound pills, powders, and laxative draughts should be studied in this connection, such as Pilula Rhei Composita, Pulvis Jalapæ Compositus, and Mistura Sennæ Compositus. Caryophyllum is slightly astringent, by virtue of its tannic acid.

2. ACTION ON THE BLOOD.

The aromatic oils of cloves and its allies enter the blood as such, and whilst oxydised in part by the red corpuscles, leave the circulation mainly unchanged. Some of them are known to **increase the number of white corpuscles,** possibly by acting on the lymphatic glands or spleen.

3. SPECIFIC ACTION AND USES.

The aromatic oils are rarely given in sufficient doses to produce definite specific effects on the tissues and organs. It may safely be assumed that in the main their action closely resembles that of turpentine, or that of camphor, respectively, as the one or the other compound is in excess in the particular drug. (*See* these substances.) Speaking generally, they are stimulant and antispasmodic; but let it be noted that a great part of this effect is reflex from the stomach, as described.

4. REMOTE LOCAL ACTION AND USES.

The aromatic oils are excreted by the kidneys, skin, bronchi, liver, and probably the bowels; and in passing through these structures **stimulate** and **disinfect** them. This subject is of the first importance in pharmacology, and will be best discussed under the head of turpentine, an oil which produces very marked remote effects. See *Terebinthinæ Oleum*, page 346.

Pimenta—PIMENTO.—The dried unripe berries of the Allspice tree, Eugenia Pimenta. West Indies.

Characters.—Of the size of a small pea, brown, rough, crowned with the teeth of the calyx, yellowish within, and containing two dark brown seeds. Odour and taste aromatic, hot, and peculiar.

Substances resembling Pimenta: Pepper, which has no calyx.

Composition.—Pimento contains chiefly the officinal *volatile oil,* identical with oil of cloves.

Preparations.

1. **Oleum Pimentæ.**—The oil distilled from the fruit in England. Colourless, becoming brown by keeping. Sinks in water. *Dose,* 1 to 3 min.
2. **Aqua Pimentæ.**—1 in 11½, by distillation. *Dose,* 1 to 2 oz.

Pimenta is also contained in Syrupus Rhamni.

ACTION AND USES.

The action and uses of pimento are the same as those of the preparations of cloves, and other **aromatics.**

Oleum Cajuputi—OIL OF CAJUPUT.—The Oil distilled from the leaves of Melaleuca minor. Imported from Batavia and Singapore.

Characters.—Very mobile, transparent, of a fine pale bluish-green colour. It has a strong agreeable odour, and a warm aromatic taste, and leaves a sensation of coldness in the mouth.

Composition.—Oil of Cajuput consists of *hydrate of cajuputene* ($\frac{2}{3}$), isomeric with Borneo camphor, $C_{10}H_{18}O$, and a second oil ($\frac{1}{3}$), boiling at a higher temperature.

Impurities.—Copper; detected by usual tests. Other volatile oils.

Dose.—1 to 3 min.

Preparation.

Spiritus Cajuputi.—1 in 50. *Dose,* 30 to 60 min.

Oil of Cajuput is also contained in Linimentum Crotonis. $3\frac{1}{2}$ in 8.

ACTION AND USES.

Cajuput oil resembles in its action and uses oil of cloves, just described, but it is more used externally as a **stimulant and counter-irritant.**

Eucalypti Folia—EUCALYPTUS LEAVES. (*Not Officinal.*)—The dried leaves of Eucalyptus globulus, the Blue Gum tree of Australia.

Characters.—Grey-green coriaceous leaves, 6 to 12 inches in length, $\frac{1}{2}$ to 1 inch in breadth, ensiform, smooth, entire, studded with oil glands; smell, camphoraceous; taste, bitter and pungently aromatic.

Composition.—The leaves contain 2·75 to 6 per cent. of an æthereal oil, *eucalyptol*, *resin*, *tannin*, salts, and colouring matter. Eucalyptol is a colourless mobile liquid obtained by distillation from the leaves, with a strong agreeable odour, consisting of 70 per cent. of a terpene, with cymol. It readily changes into resin, yielding ozone.

Dose.—Of the leaves, 5 gr. and upwards; of the oil, 1 to 5 min.

Preparations.

Eucalyptus Gauze; and Eucalyptus Ointment.—1 of the oil in 5.

ACTION AND USES.

Externally.—Eucalyptus oil is a powerful **antiseptic and disinfectant.** The gauze has almost supplanted carbolic acid gauze in Lister's process, as it is neither irritant locally, nor poisonous when absorbed.

Internally.—The action of eucalyptus oil is nearly the same as that of oil of turpentine, with which it is otherwise so closely allied. (See *Terebinthinæ Oleum.*) It is **antipyretic and antiperiodic** to a degree, like quinia, and was once believed to be of great value in ague, but this is now doubtful. The blue gum tree is planted in aguish districts to free the soil of malaria.

The remote local action of eucalyptus is important. It leaves the system by the kidneys and lungs, giving its odour to their excretions, and disinfecting these and the mucous surfaces. The oil is therefore indicated in pyelitis and cystitis on the one hand; and in bronchitis, dilated bronchi, and asthma on the other hand.

Granati Radicis Cortex — POMEGRANATE ROOT BARK.—The dried bark of the root of Punica Granatum. Obtained from the south of Europe.

Characters.—In quills or fragments of a greyish-yellow colour externally, yellow internally, having a short fracture, little odour, and an astringent slightly bitter taste.

Incompatibles.—Alkalies, lime-water, metallic salts, gelatine.

Composition.—Pomegranate root bark contains *tannin;* a crystallisable body *punicin;* a substance resembling mannite (see *Manna*), mucilage, etc.

Preparation.

Decoctum Granati Radicis.—1 in 10. *Dose,* 1 to 2 fl.oz.

ACTION AND USES.

Pomegranate root bark has an **anthelmintic** and slightly irritant action, much like kousso (see *Cusso,* page 242), but is somewhat **astringent** unless taken in large quantities. It has long been used in the treatment of the tape-worm, which is expelled apparently (not actually) dead by a dose of the decoction, preceded and followed by a purgative.

DIPTEROCARPINEÆ.

Chaulmoogra Oil.—The oil expressed from the seeds of Gynocardia odorata. From India.

Characters.—A pale-brownish unctuous solid, with a disagreeable smell and taste.

Composition.—Chaulmoogra oil contains a quantity of *palmitic acid*, with three other fatty acids, including *gynocardic acid*, the supposed active principle.

Dose.—2 to 15 gr.

ACTION AND USES.

Chaulmoogra oil is believed to be **a local stimulant**, and **a nutritive** when administered either by inunction or internally. It was for a time much praised in leprosy, and has been used for phthisis, lupus, psoriasis, and chronic rheumatism.

CUCURBITACEÆ.

Colocynthidis Pulpa—COLOCYNTH PULP.—The dried decorticated fruit, freed from seeds, of Citrullus Colocynthis. Imported chiefly from Smyrna, Trieste, France, and Spain.

Characters.—Light, spongy, white or yellowish-white in colour, intensely bitter in taste.

Composition.—The active principle of colocynth is a bitter glucoside *colocynthin*, $C_{56}H_{84}O_{23}$, usually amorphous, but crystallisable, and readily soluble in water.

Dose, in powder, 2 to 8 gr.

Preparations.

1. **Extractum Colocynthidis Compositum.**—Colocynth Pulp, 6; Extract of Socotrine Aloes, 12; Resin of Scammony, 4; Hard Soap, 3; Cardamom Seeds, 1; Proof Spirit, 160. *Dose*, 2 to 5 gr.
2. **Pilula Colocynthidis Composita.**—Colocynth Pulp, 1; Barbadoes Aloes, 2; Scammony, 2; Sulphate of Potash, ¼; Oil of Cloves, ¼; Water, q.s. (about ¼). *Dose*, 5 to 10 gr.

3. **Pilula Colocynthidis et Hyoscyami.**—Made like the compound pill with ⅓ its weight of Extract of Hyoscyamus. *Dose*, 5 to 10 gr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Colocynth is a powerful **gastro-intestinal stimulant** or irritant, according to the amount, causing speedy large and watery evacuations of the bowels, attended by griping and general depression unless its effect be covered by a carminative. It is one of the most powerful of officinal purgatives, acting as a **hydragogue cathartic** at once upon the muscular coat and intestinal glands and liver, the secretions of which are rendered abundant and watery.

Colocynth is always used in combination with milder purgatives and carminatives. The compound pills are extensively employed alone, or with calomel or blue pill, as an occasional purgative, to produce free evacuation of the bowels, and relieve the portal system, after free living, bilious derangement, or chronic constipation. It is less suitable as a habitual purgative. Its hydragogue effect is employed in cerebral congestion, where rapid "derivation" is required, and in dropsies, especially ascites, either alone or as the basis of a pill containing elaterium. Colocynth must be given with caution in pregnancy, and entirely avoided in delicate or irritable conditions of the stomach and bowels.

2. ACTION IN THE BLOOD; SPECIFIC AND REMOTE LOCAL ACTION.

Colocynthin may be taken up by the skin, enters the blood, and is excreted partly by the kidneys, being, according to some, a diuretic.

Ecbalii Fructus—SQUIRTING CUCUMBER FRUIT.—The fruit, very nearly ripe, of the Squirting Cucumber, Ecbalium Officinarum.

Composition.—Elaterium contains an active neutral principle, *elaterin*, $C_{20}H_{28}O_5$, occurring in small colourless silky prisms, odourless, with an intensely bitter acrid taste; insoluble in water, soluble in spirit.

Preparation.

Elaterium.—A sediment from the juice of Ecbalium Officinarum.

Source.—Made by pressing the juice from the incised fruit, straining, filtering, and drying the sediment.

Characters.—In flattened or slightly incurved pieces about 1 line thick; light, greenish-grey, friable.

Impurities.—Starch, flour, and chalk; detected by ordinary tests.

Dose.—$\frac{1}{16}$ to $\frac{1}{2}$ gr.

From Elaterium is prepared:

Pulvis Elaterii Compositus.—1 to 9 of Sugar of Milk. *Dose*, $\frac{1}{2}$ to 5 gr.

ACTION AND USES.

Elaterium acts much like colocynth, as a **gastro-intestinal irritant**, but is decidedly more violent, being the most powerful hydragogue purgative which we possess. It produces, even in doses of $\frac{1}{12}$ to $\frac{1}{6}$ gr., numerous very watery motions, with griping and considerable depression.

Elaterium is used almost entirely as a **hydragogue purgative** in dropsies and uræmia, relieving the venous pressure by free evacuation of fluid into the bowel. More rarely it is given as a rapid "derivative" in cerebral cases; and still more rarely as an evacuant in obstinate constipation. This drug must be used with caution, doses of $\frac{1}{16}$ grain being given at first, as the strength in elaterin is uncertain. It must not be ordered in catarrhal states of the stomach or bowels.

UMBELLIFERÆ.

Conii Folia—HEMLOCK LEAVES.—The fresh leaves and young branches of Spotted Hemlock, Conium maculatum; also the leaves separated from the branches and carefully dried; gathered from wild British plants when the fruit begins to form.

Characters.—Fresh leaves decompound, smooth, arising from a smooth stem with dark purple spots; dried leaves of a full green colour and characteristic odour. The leaf rubbed with solution of potash gives out strongly the odour of conia.

Dose, in powder.—2 to 8 gr.

Conii Fructus—HEMLOCK FRUIT.—The dried ripe fruit of Conium maculatum, Spotted Hemlock.

Characters.—Broadly ovate, compressed laterally; half-fruit with five waved or crenated ridges. Reduced to powder and rubbed with solution of potash, they give out strongly the odour of conia.

Substances resembling Conium Fruit: Caraway, Anise, Dill, known by presence of vittæ.

Composition.—The active principle of conium is a liquid alkaloid, *conia*, $C_8H_{15}N$. It is strongly alkaline, oily, and volatile; and has a peculiarly disagreeable mouse-like odour. It is readily disengaged from the preparations of the plant by the addition of alkalies; and is liable both to conversion into an inert resinous mass by exposure, and to decomposition by heat. The preparations of conium, for these and probably other reasons, are peculiarly uncertain in strength and action. *Coniic acid*, and a second alkaloid *conhydrin*, also exist in hemlock.

Incompatibles.—Caustic alkalies, vegetable acids, and astringents.

Preparations.

A. *Of Conii Folia:*

1. **Cataplasma Conii.**—1 oz. of the *dried* leaf powdered in each.
2. **Extractum Conii.**—A green extract from *fresh* leaves. About 30 in 1. *Dose*, 2 to 6 gr.

From Extract of Conium are prepared:

a. Pilula Conii Composita.—Extract of Hemlock, 5; Ipecacuanha, 1; Treacle, q.s. *Dose*, 5 to 10 gr.

b. Vapor Conii.—Extract of Hemlock, 60 gr.; Solution of Potash, 1 fl.dr.; Water, 10 fl.dr. 20 min. for one inhalation.

3. **Succus Conii.**—3 of the expressed juice of the *fresh* leaves, with 1 of Spirit. *Dose*, 30 to 60 min. (B. Ph.)

B. *Of Conii Fructus:*

Tinctura Conii.—1 in 8. *Dose*, ½ to 1 fl.dr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally applied, as the cataplasm, conium is believed by many to be **anæsthetic** and especially to relieve the pain of cancer, as well as to promote the absorption of tumours. Careful experiment fails to confirm this opinion, the whole of the sensory nervous system remaining unaffected by the drug, except indirectly by poisonous doses.

Internally.—Conium sometimes causes irritation and vomiting.

2. ACTION ON THE BLOOD.

Conia is readily absorbed into the blood, whence it reaches the tissues.

3. SPECIFIC ACTION AND USES.

Conia is found unchanged in many of the organs after administration. Moderate doses cause a sense of weight in the legs and weakness of the knees; confusion of vision, with slight drooping of the upper lids, and swollen appearance of the eyes; giddiness, thickness of speech, and slight dysphagia. The poisonous effects of the plant are well described in the classical account of the death of Socrates.

On analysis, the action of conium is found to be as follows. The convolutions remain intact until asphyxia supervenes. The corpora striata are said to be depressed. The motor parts of the cord are but slightly affected, but their reflex excitability is moderately reduced. The **respiratory centre** in the medulla is finally **paralysed**; but the cardiac and vascular centres are not definitely influenced.

The **motor nerves are** the parts specially attacked by conium, being **paralysed from their extremities upwards**, whence the heaviness and weakness of the limbs. The muscles themselves remain irritable.

Death occurs in hemlock poisoning by asphyxia due to paralysis of the respiratory nerves and depression of the respiratory centre.

Conium, although of great interest to the pharmacologist, is but little used in medicine. It has been recommended, as large doses of the succus, in spasmodic and convulsive diseases such as tetanus, chorea, and epilepsy; in mania with muscular excitement; and in asthma, pertussis, and spasmodic affections of the larynx. The vapour would appear to afford relief in some of the last-named class of cases. Possibly the compound pill may allay spasmodic cough. The extract is an adjuvant vehicle of purgative powders such as calomel.

4. REMOTE LOCAL ACTION.

Conia is excreted unchanged, chiefly in the urine.

Assafœtida—ASSAFŒTIDA.—A gum-resin obtained by incision from the living root of Narthex Assafœtida. In Afghanistan and the Punjaub.

Characters.—In irregular masses, partly composed of tears, moist or dry. The colour of a freshly cut or broken piece is opaque white, but gradually becomes purplish-pink, and ultimately dull yellowish or pinkish-brown. Taste bitter, acrid; odour fetid, alliaceous, and persistent. It dissolves almost entirely in rectified spirit.

Composition.—Assafœtida contains 4 per cent. of a *volatile oil*, 65 per cent. of *resin*, and 25 per cent. of *gum*. Oil of assafœtida is probably complex, but consists chiefly of sulphide of allyl, $C_6H_{10}S$, to which the unpleasant odour is due. The resin also contains sulphur.

Impurities.—Earthy matter.

Substances resembling Assafœtida: Galbanum, Ammoniacum, Benzoin; known by odour.

Dose.—5 to 20 gr.

Preparations.

1. **Enema Assafœtidæ.**—30 gr. in 4 fl.oz. of water.
2. **Pilula Aloes et Assafœtidæ.**—1 in 4. (See *Aloes*, page 359.) *Dose*, 5 to 10 gr.
3. **Pilula Assafœtidæ Composita.**—Syn.: Pilula Galbani Composita. Assafœtida, 2; Galbanum, 2; Myrrh, 2; Treacle, by weight, 1. *Dose*, 5 to 10 gr.
4. **Spiritus Ammoniæ Fœtidus.**—Assafœtida, 1½; Strong Solution of Ammonia, 2; Spirit, 20. *Dose*, ½ to 1 fl.dr.
5. **Tinctura Assafœtidæ.**—1 in 8. *Dose*, ½ to 1 fl.dr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Assafœtida **possesses the action of other volatile oils** and resin upon the alimentary canal, but differs from them in this highly important respect, that whilst most of them are aromatic and pleasant to the palate, it is **extremely disagreeable.** The mental effect of this nauseous impression, added to the other stimulant effects on the mouth and stomach (see *Caryophyllum*, page 242), constitute assafœtida a powerful **nervine stimulant,** which arrests the emotional disturbance, muscular spasms, and other morbid nervous disorders of hysteria. It is no longer used in true epilepsy, chorea, laryngismus, or asthma. The **stimulant action** of volatile oils **on the bowel** (see *Terebinthinæ Oleum*, page 343) is specially marked and is employed in the Enema Assafœtidæ to expel flatulence, relieve constipation, and arrest convulsions.

2. ACTION IN THE BLOOD; SPECIFIC, AND REMOTE LOCAL ACTION AND USES.

The volatile oil of assafœtida passes through the blood and tissues, and is excreted in the urine, sweat, breath, and discharge from wounds. Thus remotely it exerts the usual stimulant action of ethereal oils, and is sometimes given as a **stimulant and disinfectant expectorant** in chronic bronchitis.

Galbanum—GALBANUM.—A gum-resin, derived from an unascertained umbelliferous plant (said to be Ferula galbaniflua). Imported from India and the Levant.

Characters.—In irregular tears, about the size of a pea, usually agglutinated into masses; of a greenish-yellow colour, translucent; having a strong disagreeable odour, and an acrid bitter taste.

Substances resembling Galbanum: Ammoniacum, Assafœtida, Benzoin; known by odour.

Composition.—Galbanum contains 3 to 6 per cent. of *volatile oil*, isomeric with turpentine, $C_{10}H_{16}$, *gum*, and a mixture of *resins*, which yield by dry distillation a blue oil, and *umbelliferon*, in colourless, tasteless, odourless, satiny crystals.

Preparations.

Emplastrum Galbani.—1 in 11.

Galbanum is also an ingredient of Pilula Assafœtidæ Composita. 1 in 3½. See *Assafœtida*, page 252.

ACTION AND USES.

Galbanum acts and is used much **like assafœtida** and ammoniacum, and is always given with either of these substances.

Ammoniacum—AMMONIACUM.—A gum-resinous exudation from Dorema Ammoniacum. Collected in Persia and the Punjaub.

Characters.—In tears or masses; the tears from two to eight lines in diameter, pale cinnamon-brown, breaking with a smooth shining opaque white surface; the masses composed of agglutinated tears; hard and brittle when cold, but readily softening with heat. Has a faint odour, and a bitter acrid nauseous taste. Rubbed with water it forms a nearly white emulsion.

Substances resembling Ammoniacum: Assafœtida, Galbanum, Benzoin; known by odour.

Composition.—Ammoniacum contains about 4 per cent. of a *volatile oil*, 20 per cent. of *gum*, and 70 per cent. of *resin*. The oil does not contain sulphur.

Dose.—10 to 20 gr.

Preparations.

1. **Emplastrum Ammoniaci cum Hydrargyro.**—About 1 in 1¼. (See *Hydrargyrum*, page 86.)
2. **Mistura Ammoniaci.**—A milk-like emulsion. 1 in 32 water. *Dose*, ½ to 1 fl.oz.

Ammoniacum is also an ingredient of Emplastrum Galbani, 1 in 11; Pilula Ipecacuanhæ cum Scillâ, 1 in 7; and Pilula Scillæ Composita, 1 in 6.

ACTION AND USES.

The action of ammoniacum closely resembles that of the other aromatics and oleo-resins, but it is used almost solely for its remote local effects. In being excreted by the bronchial mucosa, it stimulates the surface and disinfects the secretions of the part (see *Terebinthinæ Oleum*, page 343); and it probably acts similarly on the skin. It is used as a **disinfectant expectorant** in chronic bronchitis with profuse discharge, and as a constituent of plasters intended to strengthen circulation in the skin and promote absorption.

Oleum Anisi—OIL OF ANISE.—The oil distilled in Europe from the fruit of Pimpinella Anisum. Also the oil distilled in China from the fruit of Illicium anisatum, Star Anise (Magnoliaceæ.)

Characters of the fruit.—Half fruits with five filiform equal ridges, the lateral ones being marginal. In each channel are three or more vittæ. Thicker and more ovate than caraway fruits.

Characters of the oil.—Colourless or pale yellow, with the familiar odour of anise, and a warm sweetish taste. Concretes at 50°.

Composition.—Oil of aniseed, *anethol*, or anise-camphor, is composed of two isomeric bodies, the *fluid* (⅕), and the *solid* (⅘), anethol.

Dose.—2 to 5 min.

Preparation.

Essentia Anisi.—1 in 5. *Dose*, 10 to 20 min.

Oil of Anise is also contained in Tinctura Camphoræ Composita, and Tinctura Opii Ammoniata.

ACTION AND USES.

The action and uses of anise are those of the **aromatic** oils in general. It is believed, however, to possess specially stimulant action on the bronchial mucosa, like ammoniacum, probably because excreted in part by it. It is therefore a favourite flavouring agent for cough mixtures.

Coriandri Fructus—Coriander Fruit.—The dried ripe fruit of Coriandrum sativum. Cultivated in Britain.

Characters.—Globular, nearly as large as white pepper, beaked, finely ribbed, yellowish-brown; has an agreeable aromatic odour and flavour.

Composition.—The principal constituents of coriander are an abundant *fatty oil*, and a small quantity of *aromatic oils*, one of which is isomeric with Borneo camphor, $C_{10}H_{18}O$. See *Camphora.*

Preparation.

Oleum Coriandri.—Obtained by distillation. Yellowish, with the odour of coriander. *Dose*, 2 to 5 min.

Coriander Fruit and Oil are also contained in a variety of preparations of more important drugs.

ACTION AND USES.

The action and uses of coriander do not differ from those of the **aromatic** substances just described. Its flavour specially covers the taste of senna and rhubarb.

Fœniculi Fructus—Fennel Fruit.—The fruit of Fœniculum dulce. Imported from Malta.

Characters.—About three lines long and one line broad; elliptical, slightly curved, beaked, having eight pale-brown longitudinal ribs, the two lateral being double; taste and odour aromatic.

Substances resembling Fennel: Conium, Caraway, Anise. Fennel is larger than Conium, and has eight ribs and often footstalk.

Composition.—Fennel contains an ethereal *volatile oil*, apparently identical with anethol (see *Oleum Anisi*, page 255;) united with a terpene. It is of a light yellow colour, with the peculiar odour of the fruit.

Preparation.

Aqua Fœniculi.—1 in 10 by distillation. *Dose*, 1 to 2 fl.oz.

ACTION AND USES.

Fennel has the same action, and is used for the same purposes as other **aromatic** substances.

Carui Fructus—CARAWAY FRUIT.—The dried fruit of Carum Carui. Cultivated in England and Germany.

Characters.—Fruit usually separating into two parts, which are about two lines long, curved, tapering at each end, brown, with five paler longitudinal ridges; having an agreeable aromatic odour and spicy taste.

Substances resembling Caraway: Conium, Fennel. Caraway has small ridges and a spicy taste.

Composition.—Volatile oil of caraway, the active constituent of the fruit, is a mixture of *caruen*, $C_{10}H_{16}$, isomeric with turpentine, and *caruol*, $C_{10}H_{11}O$, isomeric with thymol.

Preparations.

1. **Aqua Carui.**—1 in 10. *Dose*, 1 to 2 fl.oz.
2. **Oleum Carui.**—Obtained by distillation. Pale yellow, with aromatic odour and spicy taste. *Dose*, 2 to 5 min.

Caraway Fruit and Oil are also contained in many preparations of other drugs.

ACTION AND USES.

Caraway acts like other **aromatic** substances, as described under *Caryophyllum.* It is extensively used as a flavouring and carminative agent.

Anethi Fructus—DILL FRUIT.—The fruit of Anethum graveolens. Cultivated in England, or imported from middle and southern Europe.

Characters.—Oval, flat, about a line and a half in length, with a pale membranous margin. Odour aromatic; taste warm, somewhat bitter.

Substances resembling Dill: Conium, Anise, Fennel, Caraway. Dill is winged.

Composition.—Dill contains the officinal *volatile oil*, which is pale yellow, with a pungent odour, and an acrid sweetish taste.

Preparations.

1. **Aqua Anethi.**—1 in 10. *Dose*, 1 to 2 fl.oz.
2. **Oleum Anethi.**—Obtained by distillation. *Dose*, 2 to 5 min.

ACTION AND USES.

The same as of other substances containing **aromatic** volatile oils. It is often given as a carminative to infants.

Sumbul Radix—SUMBUL ROOT.—The dried transverse sections of the root of a plant the botanical history of which is unknown. Imported from Russia, and also from India.

Characters.—The pieces are nearly round, from 2½ inches to 5 inches in diameter, and from ¾ to 1½ inches in thickness. They are covered on the outer edge with a dusky brown rough bark, frequently beset with short bristly fibres. The interior is porous, and consists of irregular, easily separated fibres. It has a strong odour, resembling that of musk. The taste is at first sweetish, becoming after a time bitterish and balsamic. That brought from India differs from the Russian, being closer in texture, more dense and firm, and of a reddish tint.

Composition.—Sumbul contains a small quantity of *volatile oil*, 9 per cent. of a soft *resin* with its characteristic odour, and a crystalline substance, *sumbulic acid.*

Preparation.

Tinctura Sumbul.—1 in 8. *Dose*, 15 to 30 min.

ACTION AND USES.

Sumbul is a stimulant, like the **aromatic** oils in general, and specially resembles valerian and musk. It is used in the same class of cases as these drugs, to the account of which the reader is referred.

CAPRIFOLIACEÆ.

Sambuci Flores—ELDER FLOWERS.—The fresh flowers of Sambucus nigra. From indigenous plants.

Characters.—Flowers small, white, fragrant, in cymes.

Composition.—Elder flowers contain a trace of *volatile oil*, a *resin*, and *baldrianic* (valerianic) *acid*, $C_5H_{10}O_2$.

Preparation.

Aqua Sambuci.—1 in 1, by distillation. *Dose*, 1 to 2 fl.oz.

ACTION AND USES.

Elder flowers are chiefly used for **flavouring** purposes, but probably possess mild diaphoretic and diuretic properties.

CINCHONACEÆ.

Cinchonæ Flavæ Cortex—YELLOW-CINCHONA BARK.—The bark of Cinchona Calisaya. Collected in Bolivia and southern Peru.

Characters.—In flat pieces, uncoated or deprived of the periderm, rarely in coated quills, from six to eighteen inches long, one to three inches wide, and two to four lines thick, compact and heavy; outer surface brown, marked by broad shallow irregular longitudinal depressions; inner surface tawny-yellow, fibrous; transverse fracture shortly and finely fibrous. Powder cinnamon-brown, somewhat aromatic, persistently bitter.

Cinchonæ Pallidæ Cortex—PALE-CINCHONA BARK.—The bark of Cinchona Condaminea, D.C., *vars.* Chahuarguera *Pavon*, and crispa *Tafalla.* From Loxa.

Characters.—From half a line to a line thick, in single or double quills, from 6 to 15 inches long, 2 to 8 lines in diameter, brittle, easily splitting longitudinally, and breaking with a short transverse fracture; outer surface brown and wrinkled, or grey and speckled with adherent lichens, with or without numerous transverse cracks; inner surface bright orange or cinnamon-brown; powder pale brown, slightly bitter, very astringent.

Cinchonæ Rubræ Cortex—RED-CINCHONA BARK.—The bark of Cinchona succirubra. Collected on the western slopes of Chimborazo.

Characters.—In flat or incurved pieces, less frequently in quills, coated with the periderm, varying in length from a few inches to two feet, from one to three inches wide, and two to six lines thick, compact and heavy; outer surface brown or reddish-brown, rarely white from adherent lichens, rugged or wrinkled longitudinally, frequently warty, and crossed by deep transverse cracks; inner surface redder; fractured surface often approaching to brick-red; transverse fracture finely fibrous; powder red-brown; taste bitter and astringent.

Cinchona Lancifoliæ Cortex—LANCE-LEAVED CINCHONA BARK.—The bark of Cinchona lancifolia, *Mutis.* Spongy or orange Carthagena bark.

Characters.—Either in quills of various size with brownish epidermis, and whitish crustaceous and foliaceous lichens, extremely fibrous, moderately bitter; or as curved pieces, of an orange or red colour, with an extremely fibrous liber, of stringy fracture, very slightly bitter.

Composition.—Cinchona bark contains (1) four *alkaloids*, namely: *quinia*, *cinchonia*, *quinidia*, and *cinchonidia*; (2) two *peculiar acids: kinic* and *kinovic* acids; (3) a variety of tannic acid, called *cincho-tannic acid;* (4) *cinchona red;* and (5) an aromatic *volatile oil.*

1. **The alkaloids of cinchona.**—*a. Quinia*, $C_{20}H_{24}N_2O_2$, occurs (as the hydrate) in white acicular crystals, inodorous, very bitter; reacting like an alkali, and forming neutral and acid salts with acids; presenting fluorescence in dilute solutions of the sulphate; and turning the plane of polarisation to the left. An *amorphous* form of quinia is found after crystallisation of the sulphate from the mother-liquors, and from *quinoidia*, which appears to be a compound of the alkaloids with resin and colouring matters.

b. Cinchonia, $C_{20}H_{24}N_2O$, consists of colourless prisms, inodorous, and bitter; forms salts with acids; but possesses no fluorescence in solution; and deflects the plane of polarisation to the right.

c. Quinidia, $C_{20}H_{24}N_2O_2$, *i.e.* isomeric with quinia, closely resembles quinia, but crystallises in prisms, and deflects the plane of polarisation to the right.

d. Cinchonidia, $C_{20}H_{24}N_2O$, *i.e.* isomeric with cinchonia, resembles that alkaloid, but yields fluorescent solutions, and left-handed polarisation.

As a rule quinia is most abundant in yellow bark, cinchonia in pale bark, and the red bark contains a considerable proportion of each. Quinidia is specially abundant in the bark of lancifolia. More exactly, yellow bark yields 2·5 to 3·8 per cent. of quinia; pale bark, 0·7 to 1·4 per cent. of alkaloids, chiefly cinchonia or quinidia with a little quinia; the best red bark, 2·6 per cent. of quinia, and 1·5 per cent. of cinchonia.

2 and 3. **The acids of cinchona.**—*a. Kinic* or *quinic* acid, $C_7H_{12}O_6$, occurs in large colourless prisms, soluble in water. In the bark it is probably combined with the alkaloids, and is found also in the coffee-bean, the Vaccinium myrtillus, and other plants. It is closely allied to benzoic acid, and appears in the urine as hippuric acid. See *Benzoinum*, page 281.

b. Kinovic acid, $C_{24}H_{38}O_4$, "kinova bitter," is a white amorphous body, insoluble in water. It appears to be a product, with glucose, of *kinovin*, a glucoside.

c. Cincho-tannic acid, the astringent principle and soluble red-colouring matter of the bark, amounts to 1 to 3 per cent. It is a yellow hygroscopic body, and differs from ordinary tannic acid in striking green with persalts of iron, and in being very readily oxydised, one of the products being

4. **Cinchona red**, a reddish-brown substance without taste or smell, nearly insoluble in water.

5. **The volatile oil**, obtained by distillation, has the odour of the bark.

Impurities.—Inferior barks are detected by the absence of the true characters of the officinal barks, and by a quantitative test. This consists in (1) boiling 100 gr. of the bark in water acidulated with HCl, macerating, and percolating; (2) precipitating the colouring matter with solution of subacetate of lead; (3) adding caustic potash to the filtrate, until the precipitate first formed is nearly redissolved; (4) agitating with ether, and evaporating the resulting solution. This should yield not less than 2 gr. of quinia from yellow bark; 2 gr. of alkaloids from red bark; and $\frac{1}{2}$ gr. of alkaloids from pale bark. The yellow bark is adulterated with elm, larch, and Winter's barks, known by absence of bitter taste; the pale bark with cascarilla, which is whiter; the red bark with red sandal wood, logwood, and larch barks, which are all devoid of a bitter taste.

Incompatibles.—Ammonia, lime-water, metallic salts, and gelatine. May be combined with mineral acids.

Dose of any of the barks.—15 gr. as a tonic; 1 to 2 dr. in ague.

Preparations.

A. *Of the Yellow Bark:*

1. **Decoctum Cinchonæ Flavæ.**—1 in 16. *Dose*, 1 to 2 fl.oz.
2. **Extractum Cinchonæ Flavæ Liquidum.**—4 in 1. *Dose*, 10 to 30 min.

3. **Infusum Cinchonæ Flavæ.**—1 in 20. *Dose*, 1 to 2 fl.oz.
4. **Tinctura Cinchonæ Flavæ.**—1 in 5. *Dose*, ½ to 2 fl.dr.
5. **Quiniæ Sulphas.**

B. *Of the Pale Bark* (*Cinchona Pallida*):

1. **Tinctura Cinchonæ Composita.**—Pale Bark, Bitter-Orange Peel, Serpentary, Saffron, Cochineal, and Proof Spirit. 1 in 10. *Dose*, ½ to 2 fl.dr.

C. *Of the Red Bark* there are no officinal preparations.

D. *Of the Lance-leaved Cinchona Bark*: Quiniæ Sulphas.

ACTION AND USES.

The action and uses of the Cinchona barks will be described along with those of Quinia, their most important active principle.

Quiniæ Sulphas—SULPHATE OF QUINIA. $(C_{20}H_{24}N_2O_2)_2H_2SO_4.7H_2O$.—The sulphate of an alkaloid, prepared from yellow Cinchona bark, and from the bark of Cinchona lancifolia, *Mutis*.

Source.—Made by (1) exhausting the bark with Diluted Hydrochloric Acid; (2) precipitating the Quinia with Solution of Soda; (3) dissolving this in Diluted Sulphuric Acid; and (4) crystallising out.

Characters.—Filiform silky snow-white crystals, with an intensely bitter taste. Solubility, 1 in 576 of water: 60 gr. require 60 min. of diluted sulphuric, or 100 min. of diluted phosphoric acid; and 66 gr. require 60 min. of diluted nitric acid for solution in two ounces of distilled water. 12 gr. = 1 oz. of good bark.

Impurities.—Sulphates of the other cinchona alkaloids, and of lime, chalk, magnesia; starch, boracic acid, etc.; detected by the quantitative test given above. Salicin; which gives blood-red with sulphuric acid.

Incompatibles.—Alkalies and their carbonates, astringent infusions. Nitric acid alone makes a clear mixture with sulphate of quinia.

Dose.—1 to 5 gr. as a tonic; larger doses as an antipyretic and antiperiodic.

Preparations.

1. **Ferri et Quiniæ Citras.**—16 in 100. *Dose*, 5 to 10 gr.
2. **Pilula Quiniæ.**—1 with ⅓ of Confection of Hips. *Dose*, 2 to 10 gr.

3. **Tinctura Quiniæ.**—1 in 60. *Dose*, 1 to 1½ fl.dr.
4. **Tinctura Quiniæ Ammoniata.**—1 in 60 of Solution of Ammonia and Proof Spirit. *Dose*, ½ to 2 fl.dr.
5. **Vinum Quiniæ.**—1 in 480 of Orange Wine, with Citric Acid. *Dose*, ½ to 1 fl.oz.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Quinia arrests some kinds of fermentation and decomposition, and might be used as a local **antiseptic and disinfectant** to wounds and ulcers, but for its cost. A solution of 2 gr. to 1 fl.oz., applied as a spray to the nose, relieves hay asthma. A solution of 4 gr. to 1 fl.oz. (with a minimum of diluted sulphuric acid) is recommended as a constant application in diptheritic conjunctivitis, or to wash out a foul bladder.

Internally.—Quinia is freely absorbed by the mucous membranes, and may be given either by the mouth, rectum, or subcutaneously. In the mouth, stomach, and intestine, it acts as a powerful **bitter**, possessing all the important influence on the secretions of the digestive tract described under *Calumba.* The **stomachic** effect of quinia is obtained from small doses, ½ to 2 grains, and must be kept entirely distinct from the specific effects to be presently described, otherwise confusion as to the action and value of this important drug will be the result. In small doses, like all other bitters, it improves the appetite and digestion, stimulates the heart and circulation, increases the sense of comfort and *bien être* produced by a meal; and its continued use will thus increase the bodily strength, that is, will be **tonic** in its effects. Quinia is extensively used for this purpose, especially during convalescence, in debilitated subjects, and in patients taking depressing or alterative remedies such as mercury. Larger doses (10 to 30 gr. or more), have the opposite effect, interfering with digestion, and so causing depression.

In the stomach quinia or its sulphate becomes the chloride, a soluble and diffusible salt, which readily enters the blood. Little or none escapes unabsorbed in the fæces.

2. ACTION ON THE BLOOD, AND ITS USES.

Quinia or its chloride may be found in the blood within a few minutes of its administration. Here the alkaloid produces several definite effects, namely: (1) It binds the oxygen more firmly to the hæmoglobin, so that oxygenation is less easy and less active. (2) It causes enlargement of the individual red corpuscles. (3) It paralyses the leucocytes, when given in large doses, thus checking diapedesis; and reduces the number of visible leucocytes very greatly (to one-fourth). In blood freshly drawn, it (4) retards the formation of acid (through loss of oxygen and increase of carbonic acid) which naturally occurs in blood removed from the vessels, as well as (5) the ozonising power of blood, *e.g.* on guaiacum and turpentine. Altogether, quinia manifestly **interferes with oxygenation**, the giving up of oxygen by the red corpuscles to oxydisable bodies, and with the function of the white corpuscle. The outcome of these effects will be presently considered.

3. SPECIFIC ACTION.

Quinia passes through the tissues without decomposition, quickly making its appearance in them, but not being completely excreted for several days. The maximum effect of large doses is produced in about five hours. If therefore the full specific effect be desired, a single large dose (15 to 30 gr.) must be given, and this may have to be repeated once or twice within the hour; small doses given over a length of time do not sufficiently accumulate.

The obvious phenomena produced by a full dose (15 to 30 gr.) of quinia are not by any means its most important effect. It acts most strikingly upon the nervous centres, and causes confusion of the mental faculties, noises in the ears and deafness, disorders of vision, headache, giddiness, vomiting, and possibly prostration from involvement of the cord and circulation. Of infinitely greater interest and importance are certain concomitant effects of quinia which require careful investigation for their discovery. These effects may be arranged thus:

(1) Quinia **lowers the body temperature** very moderately in the healthy subject; very markedly in the pyrexia of many acute specific fevers. It appears to be difficult to lower the normal temperature by drugs, as compensating mechanisms are probably brought into play; but the rise of temperature and the perspiration normally produced by muscular exercise are prevented by quinia. In malarial fevers, typhoid, acute pneumonia, and some forms of hectic and other periodic fevers, the defervescent effect of quinia is unquestionable.

(2) Quinia **reduces the amount of nitrogenous excretions,** *i.e.* urea and uric acid, and probably also of carbonic acid, as determined both in healthy and in fevered animals, and in man.

These two sets of effects taken together point to a powerful action of quinia in reducing the metabolism of the body, of which heat and the excretions are the two most measurable products. This conclusion is supported by other facts, observed out of the body, viz.: That (3) a solution of albumen cannot be converted into peptones in an atmosphere of ozone if quinia be present. (4) Healthy pus and fresh vegetable juices lose their ozonising power if mixed with quinia. (5) Phosphorescent infusoria (rapidly oxydating protoplasmic masses) lose their phosphorescence in the presence of quinia. (6) Fungi absorb oxygen less readily, and many forms of fermentation are arrested, in the presence of quinia. These facts indicate that quinia so combines with living cellular protoplasm as to render it less able to incorporate oxygen, and more resistant of vital change (metabolism). Now we have already seen that the oxygen actually in the corpuscles is bound more firmly to them by quinia. We may therefore conclude that the effect of quinia in the body is to check metabolism by interfering with oxygenation, with the oxydation of protoplasm generally, and with the associated action of ferments. Thus the fall of temperature produced by quinia is due to diminished production of heat in the body, not to increased loss of heat; it is effected through the tissues, not through the heat-regulating centre; and the fever-causing (pyrogenic) processes themselves (probably allied to fermentations) are also controlled by the drug, which affects their organic causes, whether living organisms or complex chemical substances.

An action such as this upon the processes of nutrition, though it might escape the notice of an ignorant observer, is more "powerful" even than the action of morphia upon a highly sensitive nervous mechanism such as the convolutions.

Turning to the other systems, we find that whilst small doses of quinia accelerate the heart and raise the pressure, as we saw when considering the stomachic effect, full doses slow and weaken the heart and lower the pressure. These effects are due to direct depression of the cardiac ganglia and muscle, and of the vessel walls and their centre, not of the cardiac centre. Respiration is accelerated by medium doses, depressed by large doses; and death, should it occur, is referable to respiratory and cardiac failure. The spleen is reduced in size, and hardened.

4. SPECIFIC USES.

The uses of quinia, which have been mainly established by experience, are in accord with these physiological results. Its specific action may be taken advantage of in the following diseases:

1. *Malaria* is remarkably benefited by quinia, which is an **antiperiodic** or direct specific, whether given to persons exposed to the morbid influence as a prophylactic measure, or to the subjects of ague. It acts best in fresh cases, the first dose of

10 gr. being given at any time with relation to the attack, and similar doses repeated five hours before the time of the next paroxysm. All forms of malarial fever are benefited by quinia, as well as many diseases and disorders of malarial origin, such as neuralgia, hepatic disturbances, etc. The functions of the liver must be maintained during this treatment of ague, and the quinia may be combined with morphia if its effects are not well marked.

2. *Febrile conditions in general* are relieved by the **antipyretic** effect of quinia, for instance, acute pneumonia, typhoid fever, puerperal fever, and septicæmia, the exanthemata, and acute rheumatism; but generally in very different degrees, so that its value is denied in some or all of them. To be of use the quinia must be very freely given (10 to 20 grains) as single doses when the temperature reaches a definite height, say 104° Fahr. Even if apyrexia do not follow, the drug may be of much benefit. In hectic fever quinia is rarely of much service; and in purely symptomatic fever, of still less use.

3. In *splenic enlargement* of malarial origin quinia is given with success, and in some cases of leukæmatous hypertrophy.

4. In *painful nervous affections*, especially headache and face-ache, the effect of quinia is well marked. Some of these cases are malarial (brow ague); but ordinary facial neuralgia and toothache will frequently yield to it. Yet quinia possesses no direct action on peripheral nerves.

5. The **tonic** action of quinia has been already referred to. This is also due in part to its removal of fever, and thus of restlessness, sleeplessness, and want of appetite. It further modifies the processes of "secondary digestion" in the liver, and may relieve hepatic disorder due to free living, especially in persons who have resided in the tropics.

5. REMOTE LOCAL ACTION AND USES.

Quinia is excreted chiefly in the urine, as the amorphous alkaloid; partly as resinoid and crystalline derivates. In passing through the urinary organs it is slightly diuretic, and occasionally irritates the passages. It also escapes by the skin, diminishing the perspiration, and very rarely causing an itching eruption, which resembles scarlatina or measles. All the mucous secretions, the milk, and pathological fluids may also contain quinia.

ACTION AND USES OF THE CINCHONA BARKS.

The cinchona barks contain but a small percentage of alkaloids, and are far too bulky for use as antiperiodics and antipyretics if quinia can be obtained. They are therefore given only as **bitter stomachics and tonics.** The amount of tannin contained in them indicates that they may be used when an astringent effect is also desired, either locally, as in passive diarrhœa, or remotely, as in sweating, chronic mucous discharges, and purulent formations; and avoided in constipation, dyspepsia, or irritability of the bowels. The red bark is especially astringent.

Cinchonia, and other non-officinal alkaloids and products of bark, may be employed as substitutes for quinia, their action being very similar. Cinchonia is from $\frac{1}{3}$ to $\frac{1}{2}$ as powerful as quinia.

Ipecacuanha—IPECACUANHA.—The dried root of Cephaëlis Ipecacuanha. Imported from Brazil.

Characters.—In pieces three or four inches long, about the size of a small quill, contorted and irregularly annulated. Colour, brown of various shades. It consists of two parts, the cortical or active portion, which is brittle, and a slender tough white woody centre. Powder pale brown, with a faint nauseous odour, and a somewhat acrid and bitter taste.

Impurities.—(1) Hemidesmus, which is cracked, but not annulated; (2) Almond meal (in powdered ipecacuanha), detected by odour of prussic acid when moistened.

Composition.—Ipecacuanha contains from $\frac{1}{4}$ to 1 per cent. of *emetin*, which is its active principle; *ipecacuanhic* or *cephaëlic acid;* starch, gum, etc. *Emetin*, $C_{20}H_{30}NO_5$, is a crystalline alkaloid, white, becoming yellow, odourless, bitter, comparatively insoluble in water, forming salts with acids which are readily dissolved in ordinary media.

Dose.—As an expectorant, $\frac{1}{2}$ to 2 gr.; as an emetic, 15 to 30 gr.

Preparations.

1. **Pulvis Ipecacuanhæ Compositus.** "Dover's Powder."—Ipecacuanha, 1; Opium, 1; Sulphate of Potash, 8. A light fawn-coloured powder. *Dose*, 5 to 10 gr.

   From Dover's Powder is prepared:

   Pilula Ipecacuanhæ cum Scillâ.—Compound Powder of Ipecacuanha, 3; Squill, 1; Ammoniacum, 1; Treacle, q.s. *Dose*, 5 to 10 gr.

2. **Pilula Conii Composita.**—1 in 6. See *Conii Folia.*
3. **Trochisci Ipecacuanhæ.**—$\frac{1}{4}$ gr. in each. *Dose*, 1 to 3.
4. **Trochisci Morphiæ et Ipecacuanhæ.**—Ipecacuanha, $\frac{1}{12}$ gr.; Hydrochlorate of Morphia, $\frac{1}{36}$ gr. in each. See *Opium*, page 187.

5. **Vinum Ipecacuanhæ.**—1 in 20 of Sherry. *Dose*, 5 to 40 min. as an expectorant; as an emetic, 3 to 6 dr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Ipecacuanha powder is irritant, and even pustulant, but is never used to produce this effect. Exposed mucous membranes are similarly affected by it. If taken as snuff it causes irritation of the nerves, sneezing, and reflex mucous secretion; and the same effect follows its application in smoke or spray to the pharynx, larynx, or lower air-passages; in some persons it excites asthma. In the form of a spray of the diluted vinum, or inhaled as the smoke of the burning powder, it is used to relieve cough due to dryness or deficient secretion of the throat and air passages.

Internally.—Reaching the stomach, ipecacuanha in very small doses (gr. $\frac{1}{4}$) is a **gastric stimulant** doubtless increasing the local circulation and secretion. It is therefore a useful addition to bitter stomachic and tonic mixtures, and will even arrest vomiting due to certain obscure conditions of the gastric nerves. The compound powder is of the greatest value in ulceration of the stomach, and some forms of dyspeptic vomiting. In larger doses (15 to 30 gr.) it acts as an **emetic**, partly by a direct effect upon the stomach, and partly by exciting the vomiting centre in the medulla (indirect emesis). This important subject will be discussed under the heading of the specific action.

In the intestines, ipecacuanha is still a stimulant, increasing the flow of mucus; and in large doses an irritant. A remarkable tolerance of the drug is, however, readily established in many persons suffering from **dysentery**, in which disease ipecacuanha has the power of arresting the inflammatory action in the bowel, checking the liquid and bloody evacuations, and often effects a complete cure. For this purpose enormous doses (30 to 90 gr.) are given, or large doses frequently repeated (20 gr. every two hours).

2. ACTION IN THE BLOOD.

Emetin passes through the blood, from the alimentary canal to the tissues, but is not positively known to affect it.

3. SPECIFIC ACTION AND USES.

Ipecacuanha (emetin) acts on the vomiting centre in the medulla, *i.e.* is an **indirect emetic**, this effect being added to the direct (gastric) action already mentioned. The ordinary doses (15 to 30 gr. of the powdered root, 3 to 6 fl.dr. of the vinum for adults) produce free evacuation of the stomach, and respiratory passages in 20 to 30 minutes, the dose often having to be repeated in 15 minutes, and the vomiting act probably occurring but once. But little nausea precedes, and moderate depression follows, the emesis. The circulation and respiration are disturbed and finally depressed by ipecacuanha, chiefly through the vomiting.

This drug is suitable as an emetic in cases where the necessity for evacuation of the stomach is not very urgent, and the subject is likely to be benefited by moderate but injured by great depression. It must not be given, therefore, in poisoning by alkaloids, such as morphia, but to children and weakly subjects in cases where the after effects of the drug will be also useful. It thus occupies a position amongst emetics between sulphate of zinc or copper and tartar emetic. Ipecacuanha may be used to empty the stomach in the early stages of sthenic fevers (less commonly than before); in cramp, whooping-cough, and the bronchitis of children, to expel membranes or mucous products from the air passages; and in acute dyspepsia with biliousness and heat of skin.

The skin is stimulated to increased secretion by ipecacuanha, which is used as a **diaphoretic,** especially combined with opium (Dover's Powder), in common colds, sore throat, and mild rheumatic attacks.

4. REMOTE LOCAL ACTION AND USES.

Emetin is excreted by the various mucous membranes, including those of the bronchi, the stomach, and bowels, and by the liver. On the bronchi it produces the same remote as immediate local action, namely, stimulation of the nerves, reflex cough, increased secretion, and, in large doses, even inflammation of the mucous membrane and lungs. Ipecacuanha is thus an expectorant, increasing at once the expulsive acts, and the amount, that is, the liquidity, of the sputa. It is the most generally used of all this class of measures, being given in acute and chronic bronchitis, in phthisis, and in most cases of cough when the phlegm is scanty and tough. Important advantages of ipecacuanha are, that, if taken in excess, it causes sickness, which is often beneficial in the bronchitis of children; and that as a diaphoretic and moderate depressant of the circulation, *i.e.* a **sedative expectorant,** it controls the fever at the same time.

Acting remotely on the liver, this drug is a **direct cholagogue,** increasing the secretion of bile; and has long been a favourite constituent of some purgative pills and aperient draughts for chronic biliousness and gouty dyspepsia.

Catechu Pallidum—PALE CATECHU.—An extract of the leaves and young shoots of Uncaria Gambir. Prepared at Singapore and in other places in the Eastern Archipelago.

Characters.—In cubes, about an inch in diameter, externally brown, internally ochrey-yellow or pale brick-red, breaking easily with a dull earthy fracture. Taste bitter, very astringent, and mucilaginous, succeeded by slight sweetness. Entirely soluble in boiling water. The decoction when cool is not rendered blue by iodine.

Composition.—Catechu chiefly contains a crystalline bitter substance, *catechin* or *catechuic acid*, $C_{13}H_{12}O_5$, probably itself inactive; and *catechu-tannic* acid, the active principle, isomeric with it, and into which it is rapidly converted by boiling or by the action of saliva, with the development of a red colour. Both catechuic and catechu-tannic acids give a green precipitate with persalts of iron.

Incompatibles.—The alkalies, metallic salts, and gelatine.

Dose.—10 to 30 gr.

Preparations.

1. **Infusum Catechu.**—1 in 27. *Dose,* 1 to 2 fl.oz.
2. **Pulvis Catechu Compositus.**—Catechu, 4; Kino, 2; Rhatany, 2; Cinnamon, 1; Nutmeg, 1. *Dose,* 20 to 40 gr.
3. **Tinctura Catechu.**—1 in 8. *Dose,* $\frac{1}{2}$ to 2 fl.dr.
4. **Trochisci Catechu.**—1 gr. in each. *Dose,* 1 to 6.

ACTION AND USES.

Catechu acts like tannic acid, and is used for the same purposes. It is a favourite **astringent** application to sore throat in the form of the lozenge, and the compound powder and tincture are very commonly prescribed for diarrhœa.

Caffein. (*Not Officinal.*)—An alkaloid obtained from Coffea arabica, the coffee plant; from Thea sinensis, the tea plant (nat. ord., Camelliaceæ); from Ilex paraguayensis, Maté, or Paraguay Tea (nat. ord., Aquifoliacæ); and from Guarana. (*See* page 211.)

Characters.—Caffein, $C_8H_{10}N_2O_4$, occurs in fine long silky white prisms, soluble in water, with a bitter taste. It is a feeble base. Tea contains 1 to 4 per cent. of caffein; coffee, 0·2 to 0·8: maté, 1·2; guarana, 5 per cent. It is closely allied to theobromin, $C_7H_8N_4O_2$, being, in fact, methyl-theobromin, $C_7H_9(CH_3)N_4O_2$, which can be made synthetically.

Incompatibles.—Tannic acid, iodide of potassium, and salts of mercury.

Dose.—1 to 5 gr., or more.

Preparation.

Citrate of Caffein, in white needles. *Dose,* 1 to 5 gr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Coffee stimulates most of the digestive glands, being sialagogue, **stomachic** and slightly **laxative.** So far it is dietetically wholesome.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION AND USES.

Caffein is absorbed into the circulation unchanged; and acts chiefly upon the central nervous system. The **cerebrum is first stimulated,** causing the clearness of intellect, the removal of languor, and the sleeplessness, familiar after a cup of strong coffee. Larger doses cause a species of narcotism; but there are great differences in this and other respects according to the individual and other circumstances. In the lower animals the spinal centres are simultaneously affected to such a degree that tetanic convulsions may occur, not unlike those caused by strychnia; but in man these effects on the lower centres are quite subsidiary. The sensory and motor peripheral nerves are not certainly affected. The muscle curve is altered in character, and **muscular contraction seems more easily executed.** The **heart is first accelerated**—another familiar effect of a full cup of coffee; it is then slowed and weakened. The blood pressure first rises and then falls. Respiration is temporarily increased, then depressed; and death occurs in this way. Metabolism is probably somewhat increased, and the temperature raised. In all these respects habit markedly reduces the influence of coffee.

Coffee and caffein may be used as a nervine stimulant and restorative in ordinary conditions of fatigue. Megrim is frequently relieved by either. Large doses must be avoided.

3. REMOTE LOCAL ACTION AND USES.

Caffein is excreted unchanged in the bile and urine, the latter presenting the characteristic odour of the substance.

In passing through the kidney, it appears to stimulate the cells, at least in some subjects, and acts as a **diuretic.** Citrate of caffein is thus a powerful, but somewhat uncertain, remedy in dropsy, whether cardiac or hepatic. It is best given after, and then along with, a stimulant diuretic, such as digitalis; for a short time; and in moderate doses.

VALERIANACEÆ.

Valerianæ Radix — VALERIAN ROOT. — The dried root of Valeriana officinalis. From plants indigenous to and also cultivated in Britain. Collected in autumn, wild plants being preferred.

Characters.—A short yellowish-white rhizome, with numerous fibrous roots about two or three inches long; of a bitter taste, and a penetrating odour, agreeable in the recent root, becoming fetid by keeping; yielding volatile oil and valerianic acid when distilled with water.

Substances resembling Valerian: Serpentary, Arnica, Veratrum Viride, known by odour.

Composition.—The active principles of valerian are a *volatile oil* and *valerianic acid.* The oil consists of a terpen *valerene,* $C_{10}H_{16}$, and an oxygenated oil, *baldrian camphor,* $C_{12}H_{20}O$. Valerianic acid, $C_5H_{10}O_2$, occurs in a large number of other plants, and in cod-liver oil; and can be derived from fousel oil (amylic alcohol, or valeryl-aldehyd), $C_5H_{12}O$, by oxydation. It is a colourless oily fluid, with a powerful odour and acid burning taste; soluble in 30 parts of water, and freely in alcohol and ether.

Dose, in powder.—10 to 30 gr.

Preparations.

A. *Of Valerian Root:*

1. **Infusum Valerianæ.**—1 in 36. *Dose,* 1 to 2 fl.oz.
2. **Tinctura Valerianæ.**—1 in 8 of Proof Spirit. *Dose,* 1 to 2 fl.dr.
3. **Tinctura Valerianæ Ammoniata.**—1 in 8 of Aromatic Spirit of Ammonia. *Dose,* ½ to 1 fl.dr.

B. *Containing Valerianic Acid:*

Sodæ Valerianas.—Valerianate of Soda. $NaC_5H_9O_2$.

Source.—Made by (1) distilling Amylic Alcohol with Sulphuric Acid and Bichromate of Potash; (2) saturating the distillate with Liquor Sodæ, evaporating, liquefying, and cooling. (1) $3C_5H_{12}O + 8H_2SO_4 + 2K_2Cr_2O_7 = 3C_5H_{10}O_2 + 2(K_2SO_4.Cr_23SO_4) + 11H_2O$. (2) $C_5H_{10}O_2 + NaHO = NaC_5H_9O_2 + H_2O$.

Characters.—Dry white masses, not alkaline; soluble in spirit.

Impurities.—Sulphuric acid, and free soda, detected by litmus.

Dose.—1 to 5 gr.

From Sodæ Valerianas is made:

Zinci Valerianas.—Valerianate of Zinc. $Zn(C_5H_9O_2)_2$.

Source.—Made by mixing solutions of Sulphate of Zinc and Valerianate of Soda, evaporating, and crystallising. $ZnSO_4 + 2(NaC_5H_9O_2) = Zn2(C_5H_9O_2) + Na_2SO_4$.

Characters.—Pearly crystalline scales, with a feeble odour of valerianic acid, and a metallic taste. Scarcely soluble in water, soluble in spirit.

Impurities.—Sulphate and butyrate of zinc.

Dose.—1 to 3 gr.

ACTION AND USES.

Valerian acts essentially like other substances containing volatile oils, but its pungent taste and peculiarly disagreeable odour add to the effect of the drug upon the central nervous system. The stomach and intestines, heart, circulation, and brain are influenced as they are by cloves (see *Caryophyllum*), and the oil is excreted, like its allies, in the urine, breath, and sweat, as is also the valerianic acid.

Valerian is used as a powerful **carminative, circulatory stimulant, and antispasmodic,** in hysterical flatulence, fainting, palpitation, convulsions, and contractures. It is now but rarely given in other spasmodic affections, such as epilepsy, pertussis, and asthma. Valerianate of zinc was introduced to combine the alterative action of the metal on the nervous system with the antispasmodic influence of valerian root, and has been given in hysteria and epilepsy. Valerianic acid, however, does not appear to possess any of the action of the volatile oil just described.

COMPOSITÆ.

Pyrethri Radix—PELLITORY ROOT.—The root of Anacyclus Pyrethrum, imported from the Levant.

Characters.—In pieces about the length and thickness of the little finger, covered with a thick brown bark, studded with black shining points. Breaks with a resinous fracture, and presents internally a radiated structure. When chewed, it excites a prickling sensation in the lips and tongue, and a glowing heat.

Substance resembling Pellitory: Taraxacum, which is darker and of different taste.

Composition.—Pyrethrum contains one or more *æthereal oils* and *resins*, *inulin*, and possibly a substance allied to *piperin.* See *Piper Nigrum*, page 329.

Preparation.

Tinctura Pyrethri.—1 in 5.

ACTION AND USES.

Pellitory causes a sharp burning sensation in the mouth, followed by persistent tingling and numbness, and a profuse flow of saliva, stimulating as it does the local nerves and vessels and afterwards depressing the former. It has been used only for these local effects, to relieve pain and paralysis in connection with the mouth, and as a **sialagogue** to promote a gentle flow of saliva in dryness of the throat. It gives a "clean" taste to flat dentifrices, such as chalk.

Pyrethrum Roseum (*Not Officinal*). — The powder of the flower-heads used as insect powder.

Santonica — SANTONICA. — The unexpanded flower-heads of an undetermined species of Artemisia. Imported from Russia.

Characters.—Flower-heads rather more than a line in length and nearly half a line in breadth, fusiform, blunt at each end, pale greenish-brown, smooth; resembling seeds in appearance, but consisting of imbricated involucral scales with a green midrib, enclosing four or five tubular flowers; odour, strong; taste, bitter, camphoraceous. Flower-heads not round or hairy.

Composition.—Santonica contains *santonin*, and a compound *volatile oil*, allied to camphor in its action.

Dose.—10 to 60 gr.

From Santonica is made:

Santoninum, Santonin. $C_{15}H_{18}O_3$. A neutral principle obtained from Santonica.

Source.—Made by (1) boiling Santonica with Lime, and straining; (2) acidulating the hot concentrated fluid portion with

Hydrochloric Acid, to precipitate the santonin; (3) washing this with Ammonia and water, and drying; and (4) dissolving it in spirit, purifying with charcoal, and crystallising out.

Characters.—Brilliant, white, four-sided flat prisms, becoming yellow by exposure to light; odourless, tasteless or feebly bitter; scarcely soluble in cold water.

Dose.—1 to 4 gr. for a child; 2 to 6 gr. for an adult.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Santonin acts as a poison to the *Ascaris lumbricoides*, or round worm, which infests the intestine; decidedly less so to the *oxyuris vermicularis*, or thread-worm. It is used as our most valuable **anthelmintic** against the former parasite, either combined with a purgative vermifuge, such as Pulvis Scammonii Compositus, or followed in a few hours by a laxative, such as castor-oil.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION.

Santonin is absorbed into the blood as sodium santonate; enters the tissues; and produces peculiar **disturbances of vision** and the cerebral faculties. Objects appear first as blue, and then as yellow (chromatopsia), and finally colour vision is almost lost. **Consciousness is disturbed,** with a kind of intoxication, tremors, debility, and convulsions after large doses. Respiration is enfeebled, and the pulse reduced in frequency. These effects must be carefully avoided in ordering santonin as an anthelmintic.

3. REMOTE LOCAL ACTION.

Santonin is excreted by the kidneys as an obscure product of its oxydation in the system, which colours the (acid) urine greenish-yellow, alkaline urine red or purple, and causes some diuresis.

Anthemidis Flores—CHAMOMILE FLOWERS.—The dried single and double flower-heads of the common chamomile, Anthemis nobilis. Wild and cultivated.

Characters.—The single variety consists of both yellow tubular and white strap-shaped florets; the double, of white strap-shaped florets only; all arising from a conical scaly receptacle; both varieties, but especially the single, are bitter and very aromatic.

Composition.—Chamomile flowers contain the officinal bluish-coloured *volatile oil*, a complex compound of a peculiar camphor and various æthers and acids; and a *bitter extractive*, the active principle of which has not been separated.

Preparations.

1. **Extractum Anthemidis.**—A concentrated decoction, with the addition of the Oleum. *Dose*, 2 to 10 gr.
2. **Infusum Anthemidis.**—1 in 20. *Dose*, 1 to 3 fl.oz. as stomachic; 5 to 10 as emetic.
3. **Oleum Anthemidis.**—The oil distilled in Britain from the flowers. *Dose*, 2 to 4 min.

ACTION AND USES.

Externally.—Warm infusions or decoctions, or the flowers in bags soaked in hot water, possess the general properties of fomentations and poultices, the warm water being apparently the active constituent. They are much used as a domestic application to painful parts.

Internally.—Chamomile belongs to the class of **aromatic bitter stomachics.** The warm Infusion, freely drunk, is a mild simple **emetic,** which may be used in biliousness, ague, etc. The Oil or the Extract is usefully combined with purgative pills as a stomachic and carminative.

Taraxaci Radix—DANDELION ROOT.—The fresh and dried roots of Taraxacum Dens Leonis. Gathered between September and February, from meadows and pastures in Britain.

Characters and tests.—Tap-shaped roots, smooth and dark-brown externally, white within, easily broken, and giving out an inodorous bitter milky juice, which becomes pale-brown by exposure.

Substances resembling Taraxacum: Aconite, Armoracia, Pellitory. Dandelion is not wrinkled or pale-coloured externally; the juice not watery; any adherent leaves runcinate and quite smooth; is not pungent when chewed.

Composition.—Taraxacum root and the fresh juice contain an indifferent principle *taraxacin*, amorphous or in small white masses; abundance of potassium and calcium *salts; sugar;* and *resinoid bodies* which give the milky appearance to the juice. The relative richness of the taraxacin, salts, and sugar varies with the season and situation.

Preparations.

1. **Decoctum Taraxaci.**—1 of *dried* root in 20. *Dose*, 2 to 4 fl.oz.
2. **Extractum Taraxaci.**—A fresh extract. 100 of *fresh* root in 8, by expression, separation of albumen, and evaporation. *Dose*, 5 to 15 gr.
3. **Succus Taraxaci.**—Fresh juice, 3; Spirit, 1. *Dose*, 2 to 4 fl.dr.

ACTION AND USES.

Taraxacum combines the properties of its two principal constituents, the bitter taraxacin and the alkaline salts, *i.e.* it is at once a simple **bitter** and a mild **laxative.** It is therefore indicated, and was formerly extensively given in atonic dyspepsia attended by habitual constipation; and its preparations may be added to stomachic mixtures and laxative pills. Until recently taraxacum was believed to be a cholagogue; but this effect, if it exist at all, appears to be indirect only.

Lactuca—LETTUCE.—The flowering herb of Lactuca virosa, a native of Britain.

Composition.—Extract of lettuce contains, besides many other ingredients, a crystalline bitter principle, *lactucin*, and *lactucic acid*, of uncertain composition.

Preparation.

Extractum Lactucæ.—A green extract. 1½ in 1. *Dose*, 5 to 10 gr.

ACTION AND USES.

Lactucin is slightly **hypnotic.** The extract may cause some confusion of mind, headache, and diaphoresis; and acting as a mild sedative and **carminative,** it makes an excellent pill-basis for some purgatives, such as calomel.

Arnicæ Radix—ARNICA ROOT.—The dried rhizome and rootlets of Arnica montana. Collected in the mountainous parts of middle and southern Europe.

Substances resembling Arnica: Valerian, known by smell; Serpentary, with very many contorted rootlets; Veratrum Viride, with thicker rootlets.

Characters.—Rhizome from one to three inches long, and two or three lines thick, cylindrical, contorted, rough from the scars of the coriaceous leaves, and furnished with numerous long slender fibres; has a peppery taste and peculiar odour.

Composition.—The pharmacology of arnica is still obscure. It contains a small quantity of *volatile oil*, of complex composition, and said to yield *trimethylamin; tannic acid;* and a bitter substance, *arnicin.*

Preparation.

Tinctura Arnicæ.—1 in 20. *Dose*, 1 to 2 fl.dr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Arnica, applied to the skin, sometimes causes hyperæmia, eczema, and even spreading erysipelas. It would, therefore, appear to **increase the activity of the circulation in the skin**; and the tincture in water is a popular application to bruises, preventing swelling, and hastening the absorption of effused blood. It must be used with caution.

Internally.—Arnica is a **stimulant to the alimentary canal,** like volatile oils in general; in over-doses a powerful irritant, causing vomiting, pain, and purging, with consequent constitutional effects. Probably by reflex action from the stomach (see *Caryophyllum*, page 242) it stimulates the heart and circulation, the brain and spinal cord, in moderate doses; the pulse being strengthened, and symptoms of nervous debility removed. Arnica has, therefore, been used with success in low forms of fever, delirium tremens, and mental disorder.

2. ACTION ON THE BLOOD, AND SPECIFIC ACTION AND USES.

The active principles of arnica enter the blood and thence the tissues, where its effects somewhat resemble those of turpentine. If the dose be considerable, the reflex stimulant effect from the stomach is overcome by its **depressing action on the circulation and nerve centres**; headache, unconsciousness, and convulsions being induced, and the body temperature lowered. Arnica has thus been employed as an antipyretic, especially in acute rheumatism, but cannot be said to be used now.

3. REMOTE LOCAL ACTION AND USES.

Like its allies, arnica is a remote stimulant of the kidneys and skin, and has been given in some cutaneous diseases such as eczema, and in chronic rheumatism.

LOBELIACEÆ.

Lobelia—LOBELIA.—The dried flowering herb of Lobelia inflata. Imported from North America.

Characters.—Stem angular; leaves alternate, ovate, toothed, somewhat hairy beneath; capsule ovoid, inflated, ten-ribbed; herb acrid. Usually in compressed rectangular parcels.

Composition.—Lobelia contains an active principle, *lobelina*, an oily, liquid, and volatile alkaloid, with a pungent taste, and an odour like tobacco. It forms salts with acids. *Lobelic acid* is united with the lobelina.

Incompatibles.—The caustic alkalies, which decompose lobelina.

Preparations.

1. **Tinctura Lobeliæ.**—1 in 8 Proof Spirit. *Dose*, 10 to 30 min.
2. **Tinctura Lobeliæ Ætherea.**—1 to 8 Spirit of Ether. *Dose*, 10 to 30 min.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Lobelia is a **gastro-intestinal stimulant**; in large doses an irritant, causing vomiting, pain, purging, and the ordinary symptoms of depression. It is not to be used as an emetic, but is sometimes useful in obstinate constipation.

2. ACTION ON THE BLOOD, AND SPECIFIC ACTION AND USES.

The active principles of lobelia appear to enter the blood and tissues, where severe specific effects are produced by free doses, including general depression, muscular tremors and weakness, giddiness, headache, failure of the heart and breathing, and cold perspiration: a condition resembling collapse. The exact mode of the action of the drug is not known, but it appears to depress the convolutions secondarily only; to lower the activity of the motor centres in the cord, and cause muscular relaxation: to **depress the respiratory centre**, and **relax the bronchial muscles**; and to diminish the force of the heart and the tension of the vessels, after brief increase of the latter. Lobelia kills through the respiratory centre, like its ally, tobacco, and not through the heart.

Lobelia is a favourite remedy with some practitioners for the paroxysm of asthma, for which it should be given at the commencement in doses of 1 drachm of the Tincture, repeated every fifteen minutes till nausea is produced. In 10 min. doses it is a useful addition to expectorant mixtures for bronchitis with spasm and very scanty tough sputum.

3. REMOTE LOCAL ACTION AND USES.

Lobelina is probably excreted by the kidneys and skin, and acts as a diuretic and diaphoretic. Except indirectly, these effects are not taken advantage of in medicine.

ERICACEÆ.

Uvæ Ursi Folia—BEARBERRY LEAVES.—The dried leaves of Arctostaphylos Uva Ursi. From indigenous plants.

Characters.—Obovate, entire, coriaceous shining leaves, about three-fourths of an inch in length, reticulated beneath; with a strong astringent taste, and a feeble hay-like odour when powdered; the infusion giving a bluish-black precipitate with perchloride of iron.

Composition.—Uva ursi contains an inert crystalline glucoside, *arbutin*, $C_{12}H_{16}O_7$, yielding in the urine benzoic acid; an amorphous bitter glucoside, *ericolin*, $C_{34}H_{56}O_{21}$; *tannic* and *gallic acids*; and a neutral body, *ursone.*

Incompatibles.—Iron salts, lead salts, nitrate of silver, vegetable alkaloids, gelatine.

Impurities.—Leaves of red whortleberry; detected by being dotted and not reticulated on the under surface, with crenated margins. Also box leaves, which are not astringent.

Preparation.

Infusum Uvæ Ursi.—1 in 20. *Dose,* 1 to 2 fl.oz.

ACTION AND USES.

Uva ursi possesses much the same action as Pareira and Buchu, but is more astringent in virtue of the tannic and gallic acids which it contains. The arbutin appears in the urine partly as benzoic acid. Uva ursi is used as a remote **astringent and stimulant** in diseases **of the urino-genital tract,** such as chronic catarrh of the pelvis of the kidney, bladder, and urethra.

SAPOTACEÆ.

Guttapercha—GUTTAPERCHA.—The concrete juice of Isonandra gutta. A native of Borneo, Sumatra, and other Eastern islands.

Characters and Tests.—In tough flexible pieces, of a light brown or chocolate colour. Soluble or nearly soluble in chloroform, yielding a more or less turbid solution.

Composition.—Guttapercha contains 80 per cent. of a hydrocarbon *gutta*, salts, volatile oil, fat, colouring matter, and two bodies named *alban* and *fluavil.*

Preparation.

Liquor Guttapercha.—1 in 8 of Chloroform, with 1 of Carbonate of Lead; by solution and decantation.

USES.

Guttapercha is employed for making surgical instruments and apparatus. The solution is used in Charta Sinapis.

STYRACACEÆ.

Benzoinum—BENZOIN.—A balsamic resin obtained from Styrax Benzoin. It is procured by making incisions into the bark of the tree, and allowing the liquid that exudes to concrete by exposure to the air. Imported from Siam and Sumatra.

Characters.—In lumps, consisting of agglutinated tears, or of a brownish mottled mass with or without white tears imbedded in it; has little taste, but an agreeable odour; gives off, when heated, fumes of benzoic acid; is soluble in rectified spirit and in solution of potash.

Substances resembling Benzoin: Gum resins, and resins distinguished by odour and taste.

Composition.—Benzoin consists chiefly of four different *resins*, imperfectly known, with the officinal *benzoic acid*, *cinnamic acid*, and a trace of *volatile oil.*

Preparations.

1. **Adeps Benzoatus.**—10 gr. to 1 oz.
2. **Tinctura Benzoini Composita.**—"Friar's Balsam." Benzoin, 8; Prepared Storax, 6; Balsam of Tolu, 2; Socotrine Aloes, about 1½; Spirit, 80. *Dose,* ½ to 1 fl.dr.

From Benzoinum is made:

Acidum Benzoicum. Benzoic Acid. $HC_7H_5O_2$. *Source.*—Prepared from Benzoin by sublimation. *Characters.*—Light feathery crystals, nearly colourless, having an aromatic odour. Soluble in 400 of cold water, in 12 of boiling water, in 4 of spirit. Phosphate of soda or borax aids its solubility in water, so that 1 of borax and 1 of acid are soluble in 100 of water. *Dose*, 10 to 15 gr.

From Acidum Benzoicum are prepared:
a. Tinctura Camphoræ Composita.—2 gr. to 1 fl.oz.
b. Tinctura Opii Ammoniata.—9 gr. to 1 fl.oz. See *Opium.*

From Acidum Benzoicum is made:

Ammoniæ Benzoas.—$NH_4C_7H_5O_2$. Colourless laminar crystals with the fragrant odour of benzoic acid, made by dissolving benzoic acid in solution of ammonia and water, evaporating and crystallising. Soluble in 5 of water; in 18 of rectified spirit. Sublimes without residue. *Incompatibles.*—Persalts of iron, liquor potassæ, and acids. *Dose*, 10 to 20 gr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Benzoin and its preparations are **antiseptic** and **disinfectant**, and at the same time slightly **stimulant** to the vessels. The compound tincture, or "Friar's Balsam," has been long used as an application to ulcers and foul wounds, and also to promote the healing of freshly incised wounds.

Internally.—Benzoin and its acid cause sneezing and coughing when inhaled or applied in the solid form to the nose; much diluted with watery vapour, they are mild stimulants. The compound tincture is thus a useful substance for inhalation or spray in many laryngeal diseases; and benzoic acid has been applied direct to the affected surface in diphtheria, where it acts also as a disinfectant.

Taken by the mouth, benzoic acid causes slight heat and irritation in the region of the stomach; the ammonia salt is much less irritant, and can be given in larger doses.

2. ACTION IN THE BLOOD AND USES.

Benzoin and benzoic acid enter the blood in the form of benzoate of sodium, and here, as well as in the kidneys, this acid is partly **converted into hippuric acid** by combination with a molecule of glycocoll, thus:—$C_7H_6O_2 + C_2H_5NO_2$ (glycocoll) $= C_9H_9NO_3$ (hippuric acid) $+ H_2O$. The exact source of the glycocoll is still obscure. It is *not* derived from the urea or uric acid, as was once suggested; and the use of benzoic acid to take up and carry out by the urine excess of urea in uræmia, or excess of uric acid in gout, is erroneous in theory, as it has failed in practice.

3. SPECIFIC ACTION AND USES.

Benzoic acid and its salts act upon nutrition very much like the salicylates, as far as they have been investigated; that is, they are **antipyretic,** whilst they are said to **increase metabolism.** They have been used to lower the temperature in pyæmia, acute rheumatism, and specific fevers; but their effects are very uncertain, and frequently very unpleasant. Their internal use in phthisis has quite failed, and in diphtheria they are of doubtful value.

4. REMOTE LOCAL ACTION AND USES.

Benzoic acid is excreted by the kidneys, partly unchanged, partly as hippuric acid, and occasionally as succinic acid, increasing the flow of urine; by the skin and salivary glands, unchanged, stimulating their secretions; and probably by the respiratory organs, decidedly increasing the amount of expectoration. These remote local effects are turned to useful account. The acid and its ammonia salt are extremely valuable in inflammation of the bladder with alkalinity of the secretion and phosphatic deposits, by **acidulating the urine and stimulating and disinfecting the mucous surfaces**; and they are used all the more that they are almost the only certain means of neutralising morbid alkalinity of the urine which we possess. As an expectorant, benzoic acid, chiefly as the compound tincture, or contained in Tinctura Camphoræ Composita, Tinctura Opii Ammoniata, and the balsams of Tolu and Peru, is very useful in chronic bronchitis, when the bronchial products are abundant, thick, possibly foul, the mucous membrane chronically inflamed and weak, and reflex activity low.

OLEACEÆ.

Olivæ Oleum—OLIVE OIL.—The oil expressed in the south of Europe from the ripe fruit of Olea europæa.

Characters.—Pale yellow, with scarcely any odour, and a bland oleaginous taste; congeals partially at about 36°.

Composition.—Olive oil consists of 72 per cent. of a fluid oil, *olein*, and 28 per cent. of a solid oil or stearoptene, *palmitin.* These are compounds of a base, *glyceryl* (C_3H_5), with *oleic acid* ($C_{19}H_{34}O_2$), and *palmitic acid* ($C_{17}H_{31}O_2$) respectively.

Dose, ½ to 1 fl.oz.

Preparations.

Many Plasters, Liniments, Ointments, Enema Magnesiæ Sulphatis, Charta Epispastica, and Cataplasma Lini. It is also the source of the Soaps and Glycerine.

Sapo Durus.—Hard Soap. Made with Olive Oil and Soda.

Preparations.

a. **Emplastrum Cerati Saponis.**
b. **Emplastrum Saponis.**—1 in 7⅛.
c. **Linimentum Potassii Iodidi cum Sapone.**—See *Iodum.*
d. **Linimentum Saponis.**—1 in 10.
Contained in Linimentum Opii.
e. **Pilula Saponis Composita.**—Opium, ½ oz.; Hard Soap, 2 oz.; Water, q.s. See *Opium.*

Hard Soap is also used in the preparation of many pills, several plasters, and Extractum Colocynthidis Compositum.

Sapo Mollis.—Soft Soap. Made with Olive Oil and Potash.

Sapo Mollis is contained in Linimentum Terebinthinæ.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally applied, olive oil renders the skin smoother softer, and more flexible. It is used to facilitate friction over enlarged bones, or stiff joints; and in the form of liniments, to bring active bodies, such as ammonia and lime, more thoroughly into contact with the surface in a mild form. It is also an excellent **mechanical application** to burns and certain skin diseases, by coating the surface and excluding air, and in the treatment of the effects of corrosive acids and alkalies. Inunctions with olive oil to which $\frac{1}{40}$th part of carbolic acid has been added, should be ordered in the desquamative stage of scarlet fever, as a disinfectant measure. Oil rubbed into the skin is absorbed by the lymphatics, and has a distinctly **nutritive** effect, of which use may be made in wasted children when the stomach rejects food.

Internally, oils may be similarly given in corrosive poisoning. In the stomach they are not specially changed; in the intestines they are partly emulsified, partly saponified, their glycerine being set free, and their fatty acid combining with free alkalies to form soaps. The molecular basis of the chyle is thus increased by this emulsion and soapy compound. In many persons excess of oil causes dyspepsia and loathing, especially in warm weather; and in most subjects some relaxation of the bowels or diarrhœa. As an Enema, olive oil is **laxative,** and is used in obstruction of the bowels.

2. ACTION IN THE BLOOD, SPECIFIC ACTION AND USES.

Olive oil enters the blood from the lacteals or lymphatics, and may be traced in it if given in excess. Thence it enters all the cells of the body, especially those of the connective tissues, the amount varying with a number of circumstances. Here it is fully oxydised into carbonic acid and water, and constitutes one of the kinds of **food**, increasing the amount of fat in the tissues, furnishing force, and thus saving the waste of nitrogenous tissue and the necessity of consuming quantities of nitrogenous food, but unable of itself to support life.

Oils and fats are used in many forms (olive and other vegetable oils, butter, cream, cod-liver oil, etc.), in wasting diseases, such as scrofula and phthisis, as is fully discussed under *Oleum Morrhuæ*, page 379. Olive oil is rarely used in this country, but may be taken by some patients, in the form of sardine oil, when cod-liver oil is rejected.

3. REMOTE LOCAL ACTION.

Oils are excreted as carbonic acid and water, but excess will appear unchanged in the urine. It is not a special renal irritant like linseed oil.

Glycerinum.—Glycerine, $C_3H_8O_3$. A sweet principle obtained from fats and fixed oils, and containing 5 per cent. of water.

Characters.—A clear colourless fluid, oily to the touch, without odour, of a sweet taste, a free solvent of many substances. Sp. gr., 1·250. *Dose*, 1 to 2 fl.dr.

Preparations.

1. **Glycerinum Acidi Carbolici.**—4 to 1.
2. **Glycerinum Acidi Gallici.**—4 to 1.
3. **Glycerinum Acidi Tannici.**—4 to 1.
4. **Glycerinum Amyli.**—8 to 1; heated to 240° Fahr., until a jelly is formed.
5. **Glycerinum Boracis.**—4 to 1.

Glycerine is also a constituent of:

Linimentum Potassii Iodidi cum Sapone.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Glycerine is a slightly **stimulant, antiseptic, hygroscopic,** and adhesive substance, which forms a useful application to skin diseases and small sores, such as chaps, whether alone or in combination with other remedies as a lotion, instead of ointments, which become rancid. (In the pure state it is used to preserve microscopic specimens and vaccine lymph.) Glycerinum Amyli is used as a basis for ointments.

Glycerine is readily absorbed by the unbroken skin, and will carry in with it certain active substances, such as extract of belladonna. Glycerates may thus produce specific effects. It is also applied to the cervix uteri, conjunctiva, meatus auditorius, and other exposed mucous surfaces.

Internally.—Glycerine is **very sweet,** and imparts a smooth sweet agreeable taste to nauseous or astringent mixtures, rendering the addition of sugar unnecessary. As a topical stimulant and demulcent, it is an excellent vehicle for such applications for sore throat as tannic acid. In the stomach it produces no special effect; but is a mild laxative when freely given. As an enema, it has been administered in ulceration of the bowels.

2. ACTION ON THE BLOOD.

Glycerine is freely absorbed by all surfaces, and is one of the normal products of the digestion of oils and fats in the intestines. In large quantity it is said to cause the solution of the red corpuscles, the diffusion of the hæmoglobin in the plasma, and consequent hæmoglobinuria.

3. SPECIFIC ACTION AND USES.

Glycerine has been supposed to be **nutritive,** and may contribute to the formation of adipose tissue, as a portion of the fats and oils of food must be decomposed in digestion, and the glycerine again united with the fatty acid in the process of nutrition. The results obtained from the administration of glycerine instead of oils in phthisis have been very divergent, and on the whole not encouraging. The same may be said of its use in diabetes.

4. REMOTE LOCAL ACTION AND USES.

Glycerine is decomposed in the system, and passes out as propionic, formic, and other acids. The urine of persons taking glycerine contains a reducing body which gives the copper and fermentation-tests of sugar, but is not sugar. Hæmoglobinuria after large doses has been already referred to.

Oleic Acid, $HC_{18}H_{33}O_2$. (*Not Officinal.*)—One of the constituent acids of oil obtained by the action of superheated steam.

Characters.—A yellowish oily liquid, odourless, tasteless, neutral in reaction. Sp. gr., ·800 to ·810. Insoluble in water; soluble in alcohol, chloroform, benzol, benzin, turpentine, and fixed oils. It dissolves most metallic oxides, forming indefinite solutions of oleates in excess of oleic acid.

Non-officinal Preparations of Oleic Acid.

Oleate of Mercury; Oleate of Lead; Oleate of Zinc; and various ointments and plasters.

ACTION AND USES.

Oleic acid is much more **readily absorbed by the skin** than the fixed oils from which it is derived, and preparations made with it as the solvent or basis have a high penetrating power. The oleate of mercury is now extensively employed.

Manna—MANNA.—A concrete saccharine exudation from the stem of Fraxinus Ornus, and F. rotundifolia. Obtained by making incisions in the stems of the trees, which are cultivated for the purpose, chiefly in Calabria and Sicily.

Characters.—In stalactiform pieces from one to six inches in length, and one or two inches in width, uneven, porous, and friable, curved on one side, of a yellowish-white colour, with a faintly nauseous odour, and a sweetish taste.

Composition.—Manna consists principally of about 70 per cent. of *mannite*, $C_3H_7O_3$, common sugar, and extractive matter. Mannite does not undergo vinous fermentation.

Dose.—60 gr. to 1 oz.

ACTION AND USES.

Manna is a mild **laxative,** commonly given to children for constipation, because not unpleasant and easily dissolved in milk.

LOGANIACEÆ.

Nux Vomica—NUX VOMICA.—The seeds of Strychnos Nux vomica. Imported from the East Indies.

Characters.—Nearly circular and flat, about an inch in diameter, umbilicated and slightly convex on one side, externally of an ash-grey colour, thickly covered with short satiny hairs, internally translucent, tough and horny; taste intensely bitter; inodorous.

Composition.—Nux vomica seeds contain two alkaloids: ·2 to ·5 per cent. of *strychnia*, and ·12 to 1·0 per cent. of *brucia*, united with a crystalline acid, *strychnic* or *igasuric acid*, with the ordinary constituents of seeds.

Brucia, $C_{23}H_{26}N_2O_4$, occurs in colourless prisms, pearly flakes, or masses. It is soluble in alcohol; much more soluble in water, less bitter, 38 times weaker, and 3 times slower physiologically than strychnia.

Preparations of Nux Vomica.

1. **Extractum Nucis Vomicæ.**—Spirituous. 16 in 1. *Dose*, $\frac{1}{4}$ to 1 gr.
2. **Tinctura Nucis Vomicæ.**—1 in 10. *Dose*, 5 to 30 min.

From Nux Vomica is made:

Strychnia. *Source.*—Made from Nux vomica by (1) adding a solution of Acetate of Lead to a concentrated tincture, so as to precipitate the colouring matter, etc.; (2) adding Ammonia to the solution, to precipitate the alkaloids; (3) dissolving out the Brucia by boiling Spirit, and crystallising out the Strychnia by evaporation and cooling; (4) purifying by repetition of process (3).

Characters.—Strychnia, $C_{21}H_{22}N_2O_2$, occurs in very small colourless prisms, inodorous, intensely bitter (but not to be tasted by the student except in very weak solutions). Solubility, 1 in 6,500 of cold, in 2,500 of boiling water.

Impurity.—Brucia, giving red with HNO_3.

Dose.—$\frac{1}{30}$ gr., gradually increased to $\frac{1}{8}$ gr., always in solution.

Preparation of Strychnia.

Liquor Strychniæ.—4 gr. to 1 fl.oz. of Spirit, Water, and Diluted Hydrochloric Acid. *Dose*, 4 to 10 min.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION.

Externally.—Strychnia is a powerful antiseptic, but is too poisonous to be applied to wounds.

Internally.—Nux vomica and strychnia possess all the properties of **bitters** as described under *Calumba* (page 181), to which the student will refer. Their use is not different from that of other bitters, excepting that whilst they are unpleasant from the intensity and persistency of their taste, and the absence of all covering flavour, they are very convenient on account of their small bulk. The Tincture of Nux Vomica is to be prescribed with alkalies, the Liquor Strychniæ with acids.

Strychnia is believed to **increase the peristaltic action** of the intestines, and is therefore combined with purgatives, especially aloes, for chronic constipation from atony of the bowel.

2. ACTION ON THE BLOOD.

Strychnia enters the blood from mucous surfaces, or when given hypodermically. Here it affects both the red corpuscles and the plasma, reducing the absorptive power of the former for oxygen, and the discharge of carbonic acid from the latter. These effects are not, however, the cause of the specific action of the drug immediately to be described.

3. SPECIFIC ACTION.

Strychnia quickly finds its way into the viscera, especially the nervous system, and is peculiar in remaining so long within them, that it is not wholly excreted for several days. Entering rapidly, and disappearing slowly, the alkaloid accumulates in the body if the dose, however small, be very frequently repeated, and is said to have a "cumulative action."

In medicinal doses, strychnia produces a **tonic** influence, as described under Calumba and Quinia, with a sense of increased strength and spirits. Therewith its specific action is soon developed, namely, increased sensibility of touch, sight, and hearing, with some disorder of the senses, such as of colour, vision, and smell. Repeated or larger doses next lead to sudden twitchings of the muscles of the limbs, a constricted feeling in the chest, and some dysphagia, with a sense of anxiety. Poisonous doses produce **violent convulsions**, and rapid death by exhaustion and asphyxia, from spasmodic arrest of the respiratory muscles. The phenomena resemble tetanus, but differ from it in the complete relaxation of the muscles between the convulsive seizures, in the great rapidity of their course, and in the comparative absence of trismus (lock-jaw).

Careful analysis resolves the phenomena of strychnia poisoning as follows, and enables us to understand its action in medicinal doses. The *convolutions* are unaffected. The **motor centres of the cord are powerfully irritated** by toxic doses, and this in such a way that their **reflex excitability is enormously increased.** The very slightest stimulation of the skin, such as a breath of air, a loud sound, or a bright light, is sufficient to originate reflex muscular spasms. The muscles of respiration are manifestly involved in this effect, and the vigour of their action greatly increased; and this is carried so far that they remain contracted in inspiration, and give rise to asphyxia.

The *medulla* is stimulated by strychnia in all its important centres. The **respiratory centre is increased in activity,** and transmits powerful impulses downwards to the already excited cord, thus causing increased frequency and depth of the movements of the chest. The **cardiac centre and the cardiac ganglia** and nerves appear to be **stimulated** by strychnia, but the violent contractions of the voluntary muscles completely modify the direct effect of the alkaloid, which is said actually to cause slowing of the heart (in animals paralysed by curare). Death does not occur through the heart, which beats after respiratory death, and remains contracted. The *vaso-motor* centre is also increased in vigour, an effect which is heightened by the general muscular spasm, and finally by the asphyxial state of the blood; thus the arterial pressure rises enormously for a time.

The *motor nerves and muscles* are comparatively unaffected by strychnia, but its local application appears to stimulate them. Probably the same may be said of the *sensory* nerves, vision being improved by injections of strychnia in the temple. The *body temperature* naturally rises during the convulsions.

4. SPECIFIC USES.

Strychnia is indicated in paralysis, especially paralysis from disease or disorder of the cord, but is not of much real service in this class of cases. Its function in cerebral disease is mainly to sustain the activity of the spinal centres, nerves, and muscles until the higher centres are restored; but electricity has almost entirely displaced it for this purpose It appears, however, to be useful in the so-called "reflex," or "functional," paralysis of neurotic subjects, diphtheria, or anæmia; and in *peripheral* paralysis, of the fore-arm, eyes, larynx, sphincters, etc., often toxic in origin, *e.g.* due to lead, tobacco, or alcohol. For these local cases, strychnia is best given in the form of hypodermic or intra-muscular injection ($\frac{1}{48}$ gr. of sulphate of strychnia in 10 min. of distilled water). In sensory paralysis strychnia is useless, but it appears to relieve some forms of blindness (amaurosis) when applied locally, *i.e.* hypodermically in the temple. In chronic nervous disorders, such as chorea, epilepsy, neuralgia, and asthma, it is of benefit as a bitter stomachic and tonic, an effect more generally available than the specific action of the drug.

Strychnia, as a respiratory stimulant, may be used in bronchitis, emphysema, and phthisis, to increase the vigour both of the respiratory centre and the respiratory movements. It is advantageously combined with expectorants, its tonic action being further useful. From its stimulant and tonic action on the heart and vessels, it is given with benefit in cardiac dilatation with low pressure.

Strychnia is a physiological antagonist of chloral, morphia, and physostigma, and may be given in moderate doses in poisoning by these substances, whilst all the ordinary methods of recovery are persevered in.

5. REMOTE LOCAL ACTION.

Strychnia is excreted in the urine, sweat, and saliva, as we have seen, very slowly. The practical importance of this fact has already been insisted on.

Spigeliæ Radix—CAROLINA PINK. (*Not Officinal.*)—The rhizome and rootlets of Spigelia marilandica. From the United States.

Characters.—A thick globular brown head, with numerous fine branching rootlets.

Composition.—Spigelia contains an uncrystallisable *bitter principle*, a *volatile oil*, *tannin*, etc.

Dose.—60 to 120 gr.

Non-officinal Preparation.

A Fluid Extract. *Dose*, 1 to 4 fl.dr.

ACTION AND USES.

Spigelia is an **anthelmintic**, and is directed against the round worm. It is moderately **purgative**, but should be assisted by senna or other cathartic.

Gelsemii Radix. (*Not Officinal.*)—The fresh rhizome and rootlets of Gelsemium sempervirens, the Yellow Jasmine. From the United States.

Characters.—A very light, fibrous, dirty-yellowish root, with rootlets; odour aromatic and heavy; taste bitterish.

Composition.—Gelsemium contains a powerful alkaloid, *gelsemin*, *gelsemic acid*, a *volatile oil*, and other ingredients. *Gelsemin* is a colourless, amorphous, odourless, bitter solid, forming salts with acids.

Dose of gelsemin, $\frac{1}{60}$ to $\frac{1}{20}$ gr.

ACTION AND USES.

Gelsemium is a **powerful depressant** of the motor parts of the cord, causing paralysis, which is followed later by sensory depression and anæsthesia. Respiration fails, and death occurs by asphyxia. The heart is also depressed; the skin is stimulated. The pupil is dilated, and the ocular and levator palpebræ muscles paralysed, all through the third nerve.

Gelsemium has been given in tetanus, asthma, whooping-cough, and other convulsive diseases, with uncertain results. It appears to relieve some cases of neuralgia. In sick headache it may procure great relief, if the dose be pushed.

Non-officinal Preparations.

A Fluid Extract; *Dose*, 2 to 10 min. A Tincture; *Dose*, 5 to 20 min.

APOCYNACEÆ.

Quebracho Bark. (*Not Officinal.*)—The bark of Aspidosperma Quebracho. From Chili.

Characters.—In pieces, $\frac{3}{4}$ inch thick; interior, fibrous and cinnamon-brown, with a short fracture; exterior, reddish ochre-coloured, warty; taste, bitter, slightly aromatic, unpleasant.

Composition. — Quebracho bark and wood contain an alkaloid, *aspidospermin*, $C_{22}H_{28}N_2O_2$, soluble in spirit, nearly insoluble in water. The wood contains much tannin.

Non-officinal Preparations.

Extract; Tincture (1 to 5) in doses of 5 min to 1 fl.dr.

ACTION AND USES.

Quebracho and aspidospermin **reduce the frequency of respiration**, through the centre; the heart's action through the intrinsic ganglia; the sense of dyspnœa induced by exercise; and the body temperature. The bark has been used with success in some cases of disease attended by dyspnœa, especially emphysema, but is an uncertain drug, and should be given with caution.

ASCLEPIADACEÆ.

Hemidesmi Radix — HEMIDESMUS ROOT. — The dried root of Hemidesmus indicus. Imported from India.

Characters.—Yellowish-brown, cylindrical, tortuous, furrowed, and with annular cracks, having a fragrant odour, and a very agreeable flavour.

Substances resembling Hemidesmus: Sarsaparilla, Ipecacuanha, Senega. Hemidesmus is known by cracks and absence of twisting.

Composition.—The composition of hemidesmus is imperfectly known. It is believed to contain *hemidesmic acid*, a volatile crystallisable substance.

Preparation.

Syrupus Hemidesmi.—1 in 8. *Dose*, 1 to 4 fl.dr.

ACTION AND USES.

Hemidesmus is used in India as an **alterative** in lieu of sarsaparilla, and the same obscurity exists respecting the action and value of this as of the other drug. See *Sarsæ Radix*, p. 355.

GENTIANACEÆ.

Gentianæ Radix—GENTIAN ROOT.—The dried root of Gentiana lutea. Collected in the mountainous districts of central and southern Europe.

Characters.—From half an inch to one inch in thickness, several inches in length, often twisted, much wrinkled, or marked with close transverse rings; brown externally, yellow within, tough and spongy; taste at first sweetish, afterwards very bitter.

Composition.—Gentian contains ·1 per cent. of an active bitter glucoside, *gentiopicrin*, $C_{20}H_{30}O_{12}$, which is crystalline, readily soluble in water and dilute spirit, and yields, by decomposition, glucose and *gentiogenin*. It is united with an inert non-bitter body, *gentianic acid*, sugar, gum, and a trace of a *volatile oil*.

Incompatibles.—Sulphate of iron, nitrate of silver, and lead salts.

Preparations.

1. **Extractum Gentianæ.**—Aqueous. *Dose*, 5 to 10 gr.

2. **Infusum Gentianæ Compositum.**—1 in 80, with Orange and Lemon Peel. *Dose*, 1 to 2 fl.oz.
3. **Mistura Gentianæ.** — 1 in 40, with Bitter-Orange Peel, Coriander, Water, and Proof Spirit. *Dose*, ½ to 1 fl.oz.
4. **Tinctura Gentianæ Composita.** — 1 in 13⅓, with Bitter-Orange Peel, Cardamoms, and Proof Spirit. *Dose*, 1 to 2 fl.dr.

ACTION AND USES.

Gentian possesses the action of other **bitters**, as described under *Calumbæ Radix.* The uses made of it correspond. It is, perhaps, the most extensively used and popular of all bitters, because (1) it is agreeable, being very slightly **aromatic**; (2) its bitter is not intense, and its astringency but slight; and (3) it is more stimulant to the bowels, and more disinfectant than some bitters. A drawback to its usefulness is the liability of the sugar which it contains to ferment in simple infusions.

Chirata—CHIRETTA.—The entire plant, Ophelia chirata. Collected in Northern India.

Characters.—Stems about three feet long, of the thickness of a goose-quill, round, smooth, pale brown, branched; branches opposite; flowers small, numerous, panicled; the whole plant intensely bitter.

Composition.—Chiretta contains an active bitter principle, *chiratin*, combined with *ophelic acid*, as well as the ordinary constituents of plants.

Substances resembling Chiretta: Dulcamara, Lobelia, Cannabis, which have no bitter taste.

Preparations.

1. **Infusum Chiratæ.**—1 in 40. *Dose*, 1 to 2 fl.oz.
2. **Tinctura Chiratæ.**—1 in 8. *Dose*, 15 to 60 min.

ACTION AND USES.

Chiretta is an **aromatic bitter**, almost identical in its action and uses with gentian; but may be given with iron.

CONVOLVULACEÆ.

Scammoniæ Radix—SCAMMONY ROOT.—The dried root of Convolvulus scammonia. From Syria and Asia Minor.

Characters.—Tap-shaped roots, sometimes three inches in diameter at the top, brown without, white within, slightly odorous, but tasteless. Ether agitated with the powder and evaporated, leaves a residue having the properties of scammony resin.

Substances resembling Scammony Root: Belladonna, which is smaller.

Scammonium—SCAMMONY.—A gum-resin, obtained by incision from the living root of Convolvulus scammonia, chiefly in Asia Minor.

Characters and tests.—Ash-grey, and rough externally; fresh fracture resinous, splintery, shining, black when dry; odour and flavour cheesy; causes, when chewed, a slight prickly sensation in the back of the throat; easily triturated into a dirty-grey powder, and converted with water into a smooth emulsion.

Impurities.—Chalk, detected by effervescence with acids; starch, by iodine test.

Composition.—Scammony consists of 77 to 83 per cent. of resin, soluble gum 6 to 8, and a little moisture. The root, the gum-resin, and the resin contain an active principle, *jalapin*, probably identical with the convolvulin of jalap.

Dose, 5 to 10 gr.

Scammoniæ Resina—RESIN OF SCAMMONY.

Source.—Made from Scammony, or Scammony Root, by preparing a tincture, and precipitating this in water.

Characters.—Brown, translucent pieces, brittle, fragrant; entirely soluble in ether.

Impurity.—Guaiacum resin, detected by giving blue with potato.

Dose.—3 to 8 gr.

Preparations.

A. *Of Scammonium:*

1. **Confectio Scammonii.**—1 in 3, with Ginger, Oil of Caraway, Oil of Cloves, Syrup, and Honey. *Dose*, 10 to 30 gr.
2. **Pulvis Scammonii Compositus.**—Scammony, 4; Jalap, 3; Ginger, 1. *Dose*, 10 to 20 gr.

Scammonium is also an important ingredient of Pilula Colocynthidis Composita (1 in 3), and of Pilula Colocynthidis et Hyoscyami (1 in 4½).

B. *Of Scammoniæ Resina:*

1. **Mistura Scammonii.**—1 in 240 of fresh milk. *Dose,* ½ to 2 fl.oz. for a child.
2. **Pilula Scammonii Composita.**—Resin of Scammony, 1; Resin of Jalap, 1; Curd Soap, 1; Strong Tincture of Ginger, 1; Spirit, 2. This is the only aperient pill in the Pharmacopœia which does not contain aloes. *Dose,* 5 to 15 gr.

Resina Scammoniæ is also an important ingredient of Extractum Colocynthidis Compositum (1 in 7).

ACTION AND USES.

Preparations of scammony are powerful **stimulants of the intestinal glands, and** to a less degree of the **liver,** causing free purgation within a few hours, attended by griping. It begins to act in the duodenum on meeting the bile, and will not purge if injected into the blood.

Scammony is used chiefly as a smart **purgative and anthelmintic** in children, in cases unattended by irritation of the stomach and bowels. As a hydragogue, jalap is generally preferred.

Jalapa—JALAP.—The dried tubercles of Exogonium purga. Imported from Mexico.

Characters.—Varying from the size of a nut to that of an orange, ovoid, the larger tubercles frequently incised, covered with a thin brown wrinkled cuticle; presenting, when cut, a yellowish-grey colour, with dark brown concentric circles.

Composition.—Jalap contains 15 to 20 per cent. of the officinal *resin,* which in turn is composed in part of *convolvulin,* $C_{31}H_{50}O_{16}$, a colourless, tasteless, odourless body, of gummy appearance. This is the anhydride of *convolvulinic acid,* into which it can be converted by alkalies. Convolvulin is probably identical with the jalapin of scammony.

Dose.—10 to 30 gr.

Jalapæ Resina.—RESIN OF JALAP.

Source.—Made by precipitating a tincture of jalap in water.

Characters.—Dark-brown opaque fragments, translucent at the edges; brittle, with a resinous fracture; with a sweetish acrid taste; readily soluble in spirit, insoluble in water.

Substance resembling Resin of Jalap : Aloes, which is bitter. *Dose,* 2 to 5 gr.

Preparations of Jalapa :

1. **Extractum Jalapæ.**—Spirituous and aqueous. 2 in 1. *Dose,* 5 to 15 gr.
2. **Pulvis Jalapæ Compositus.**—Jalap, 5; Acid Tartrate of Potash, 9; Ginger, 1. *Dose,* 20 to 60 gr.
3. **Tinctura Jalapæ.**—1 in 8. *Dose,* ½ to 2 fl.dr.

Jalap is also an important ingredient of Pulvis Scammonii Compositus.—3 in 8.

Jalapæ Resina is contained in Pilula Scammonii Composita.

ACTION AND USES.

The action of jalap closely resembles that of scammony, but it is less irritant or likely to gripe. Like it, jalap does not purge unless in the presence of the duodenal fluids; it is also a powerful **stimulant of the intestinal secretion**, less so of the bile. Small doses produce a laxative effect; large doses act within two hours, causing several watery stools, and some pain, unless combined with carminatives.

Jalap is extensively used in the form of the Compound Powder, as a **hydragogue** purgative to drain off water by the bowel in dropsy, and occasionally as an ordinary smart purgative. The resin in small doses may be used in laxative pills for habitual constipation. As an **anthelmintic**, jalap occurs in Pulvis Scammonii Compositus. This drug must be avoided when the alimentary canal is inflamed or irritable.

SOLANACEÆ.

Dulcamara—DULCAMARA.—The dried young branches of Solanum dulcamara, Bittersweet. From indigenous plants which have shed their leaves.

Characters.—Light, hollow, cylindrical, about the thickness of a goose-quill, bitter and subsequently sweetish to the taste.
Substance resembling Dulcamara : Chiretta, which has flowers, and is bitter.

Composition.—Dulcamara contains an alkaloid, *solanin,* $C_{43}H_{69}NO_{16}$, acting as a glucoside, and breaking up with weak acids into glucose and *solanidin,* $C_{25}H_{39}NO$, which can be further decomposed into two other alkaloids, *solanicin,* and modified *solanidin.*

Preparation.

Infusum Dulcamaræ.—1 in 10. *Dose,* 1 to 2 fl.oz.

ACTION AND USES.

Dulcamara is a gastro-intestinal stimulant, and in large doses causes vomiting. Its specific action is imperfectly understood, but it appears to cause paralysis by **depression of the central nervous system,** and to **lower the activity of the heart, and** especially of the **respiration.** It has been used as a diuretic and diaphoretic, but probably possesses no such action. It is very seldom prescribed.

Capsici Fructus—CAPSICUM FRUIT.—The dried ripe fruit of Capsicum fastigiatum. Imported from Zanzibar, and distinguished in commerce as Guinea Pepper and Pod Pepper.

Characters.—Pod membranous, from five to eight lines long, two lines broad, straight, conical, pointed, smooth, shining, but somewhat corrugated, orange red, intensely hot in taste.

Composition.—The active principle of capsicum is still uncertain. Various bodies have been separated, and named *capsicin, capsicol,* etc.

Impurities.—Red lead and other coloured substances.

Dose.—½ to 1 gr.

Preparation.

Tinctura Capsici.—1 in 27. *Dose,* 2 to 10 min.

ACTION AND USES.

Capsicum has a comparatively powerful local action, closely resembling that of volatile oils. It is used as a **condiment** (cayenne pepper); and medicinally in stimulant gargles, and as a **stomachic, carminative, and stimulant,** to dispel flatulence and rouse the appetite, especially in alcoholic subjects.

ATROPACEÆ.

Belladonnæ Folia—BELLADONNA LEAVES.—The fresh leaves, with the branches to which they are attached, of Deadly Nightshade, Atropa Belladonna; also the leaves separated from the branches and carefully dried; gathered from wild or cultivated British plants when the fruit has begun to form.

Characters.—Leaves alternate, three to six inches long, ovate, acute, entire, smooth, the uppermost in pairs and unequal.

The expressed juice, or an infusion, dropped into the eye, dilates the pupil.

Substances resembling Belladonna Leaves: Stramonium leaves, more wrinkled; Hyoscyamus leaves, which are hairy.

Belladonnæ Radix—BELLADONNA ROOT.—The dried root of Atropa belladonna. Cultivated in Britain or imported from Germany.

Characters.—From one to two feet long, and from half an inch to two inches thick, branched and wrinkled, brownish-white. An infusion dropped into the eye dilates the pupil.

Composition.—Besides the ordinary constituents of plants, belladonna root and leaves contain two alkaloids: (1) *atropia*, and (2) *belladonnin*, *homologous* with atropia, and *identical* with hyoscyamia, daturia, and duboisia. These alkaloids exist as malates in the plant.

Preparations.

A. *Of Belladonnæ Folia:*

1. **Extractum Belladonnæ.**—A green extract. 100 of the *fresh* leaves in 4. *Dose,* $\frac{1}{4}$ to 2 gr.

From the Extract are prepared:

a. Emplastrum Belladonnæ.

b. Unguentum Belladonnæ.—80 gr. to 1 oz. of Lard.

2. **Succus Belladonnæ.**—*Fresh* juice, 3; Spirit, 1. *Dose,* 5 to 15 min.
3. **Tinctura Belladonnæ.**—1 of *dried* leaves in 20. *Dose,* 5 to 30 min.

B. *Of Belladonnæ Radix:*

Linimentum Belladonnæ.—1 oz. to 1 fl.oz. Spirit, with Camphor.

From Belladonna Root is made:

Atropia.—Atropia, Atropin, $C_{17}H_{23}NO_3$.—An alkaloid obtained from Belladonna Root.

Source.—Made by the following process: (1) Exhausting the root with Spirit; (2) precipitating the colouring matters with Lime, and filtering, and neutralising excess of Lime with Sulphuric Acid; (3) distilling off Alcohol, substituting Water, and thus precipitating (*a*) the resins and (*b*) the Atropia; (4) removing the Atropia by solution in Chloroform, distilling off the latter, dissolving in Spirit, purifying with Charcoal, and crystallising.

Characters.—Colourless, or white acicular crystals. Sparingly soluble in water, more freely in alcohol and ether. Readily decomposed in solution. Alkaline, readily forming crystallisable salts with acids. It can be chemically resolved into *tropin* and *tropic acid;* and reconstructed by the synthesis of these bodies. One of the products of tropin, called *homatropin*, has been used as a mydriatic instead of atropia. The intimate cause of the isomerism but non-identity of atropia with the other alkaloids of the atropaceæ has yet to be discovered.

Incompatibles.—Caustic alkalies decompose it; *e.g.* Liquor Potassæ (often prescribed with belladonna) renders it inert. Opium, physostigma, and strychnia are in various respects and degrees physiological antagonists. See *Opium*, pages 192 to 197.

Preparations.

a. **Liquor Atropiæ.**—4 gr. to 1 fl.oz. of Water and Spirit. Not given internally.

b. **Unguentum Atropiæ.**—8 gr. in 1 oz.

From Atropia is made :

Atropiæ Sulphas.—Sulphate of Atropia. *Source.*—Made by dissolving Atropia in Diluted Sulphuric Acid and Water, and evaporating. *Characters.*—A colourless powder, very soluble in water and in spirit; neutral. *Dose*, $\frac{1}{120}$ to $\frac{1}{60}$ gr., but not given internally as such.

From Atropiæ Sulphas is prepared :

a. Liquor Atropiæ Sulphatis.—4 gr. to 1 fl.oz. of Distilled Water. *Dose*, 1 to 2 min., by the mouth; or 2 to 5 min. of a mixture of equal parts of the Liquor and distilled water, hypodermically.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Belladonna and atropia, as such or in aqueous suspension or solution, are not absorbed by the unbroken skin, but alcohol, chloroform, camphor, and glycerine, with which they are generally combined, readily convey the atropia through the epidermis. Exposed mucous membranes and inflamed areas of skin still more readily absorb atropia.

Belladonna depresses the sensory nerve endings, thus acting as a **local anæsthetic and anodyne**; the blood-vessels are first somewhat contracted, and then relaxed; and the motor nerve filaments to underlying muscles reduced in activity. Any other special nerve endings, with which the atropia may come in contact, are similarly depressed, *e.g.* the nerves of the sweat and mammary glands.

Belladonna is used locally as liniment, plaster, ointment, and atropia more rarely in ointment, to relieve the pain and spasm of muscular rheumatism and neuralgia (less useful); as an anodyne and antiphlogistic in acute gout, boils, erysipelas, and other superficial inflammations—in all of which Glycerine of Belladonna (equal parts of the extract and glycerine), freely smeared on, is of great service; and in prurigo and other skin diseases to relieve itching.

Internally.—The action of belladonna on the mouth is not a local but specific one, to be presently described. In the stomach it produces a slightly anodyne effect, and has been used to relieve some forms of gastralgia and sickness. Its action on the bowels is also specific, as will be seen.

2. ACTION IN THE BLOOD.

Atropia very rapidly enters the blood as such, and leaves it for the tissues. As far as is known, it does not alter the corpuscles.

3. SPECIFIC ACTION.

Atropia reaches the organs with remarkable rapidity, and sets up a train of characteristic phenomena. After moderate doses of an active preparation of belladonna, patients almost invariably complain of dryness in the throat, with difficulty of swallowing; the pupils are found to be dilated, the vision confused; the balance and gait uncertain; the bowels possibly relaxed; the pulse reduced in frequency; the conjunctiva and even the face flushed. Larger doses aggravate these phenomena, but the pulse now becomes frequent instead of the reverse; restlessness or even convulsions may occur; and the patient becomes delirious. These symptoms occasionally follow the incautious application of belladonna to wounds or erupted areas of skin.

Physiological analysis of these phenomena yields the following results:

Convolutions.—The **delirium** caused by belladonna is rarely seen after medicinal doses. It is followed by dulness, somnolence, and insensibility, all evidences of cerebral depression.

Spinal cord.—Belladonna acts by no means powerfully on the cord, beyond slightly increasing and afterwards diminishing its reflex irritability.

Medulla.—The three great vital centres in the cord are markedly affected. The **respiratory centre is powerfully stimulated** by belladonna, so that the movements of the chest become more frequent and more deep. This effect is independent of the blood pressure. Poisonous doses paralyse the same centre. The **cardiac centre is for a time stimulated** and the heart slowed. This is but a small part of the effect on the heart, as will be immediately seen. The **vaso-motor centre is first stimulated and then depressed** by belladonna: that is, the systemic arteries are contracted and the blood pressure raised for a time; afterwards the vessels relaxed, and the pressure lowered, causing the flushing of the skin. The irritability of the *motor nerves* is diminished, but not lost, except after large doses. The *voluntary muscles* remain unaffected. The *sensory nerves*, which, as we have seen, are locally depressed, are also depressed specifically. Thus pain is prevented or relieved.

Special efferent nerve terminations.—A markedly depressing action is exerted by belladonna upon the terminations of certain special motor or secretory nerves in connection with the viscera, or upon the "terminal apparatus" between these fibrils and the active protoplasm.

The **endings of the third nerve are paralysed** in the sphincter of the pupil and in the ciliary muscle, giving rise to the **dilatation of the pupil and the disturbance of accommodation.** The effect on the pupil is purely local in its cause: the muscle itself is also unaffected; possibly the sympathetic is somewhat stimulated. The amount of confusion of vision produced by the paralysis of accommodation will depend on the normal refraction of the patient's eye, long-sighted persons suffering most. The intra-ocular pressure is not diminished, as is often stated; it is increased by large doses.

The **terminations of the chorda tympani** in the *submaxillary gland* **are paralysed** by atropia, the result being arrest of saliva, and the dryness of the mouth and throat already mentioned. The sympathetic remains unaffected, so that the vessels in the gland dilate as usual under stimulation, and the "sympathetic secretion" can be obtained as before. Probably the mucous glands of the mouth are paralysed by atropia at the same time.

The **ends of the sudoriparous nerves** in the *sweat* glands **are depressed** by atropia, which is the most powerful of all anhidrotics. Therewith the skin is flushed, as we saw—overspread sometimes by a scarlatinoid redness or rash; and the temperature rises at first, but afterwards falls.

The **lacteal nerve terminations are paralysed,** and the secretion of milk (if present) arrested.

The **ends of the vagus** (inhibitory apparatus) in the *heart* may be **briefly stimulated** by atropia, thus increasing its slowing action on the cardiac centre in the medulla, already seen; but they are **quickly paralysed,** the pulse rising in frequency to twice its previous rate after full doses; and this frequency cannot be reduced by faradising the vagus. Therewith the force of the systole is *not reduced after moderate doses.* Very large (poisonous) doses depress the ganglia, and finally even the muscle, and death occurs through cardiac failure, with the ventricle in diastole. The depressor and the accelerator filaments are not affected.

It will be convenient to complete here the account of the action of belladonna on the circulation. The vaso-motor stimulation noted under the medulla, coincides with the cardiac acceleration, and thus the blood pressure is decidedly raised, the heart emptying itself more frequently into tense vessels. Large doses, however, depress the vaso-motor centre; the peripheral vessels relax; the **pressure falls**; and if this be extreme, it coincides with the paralysis of the cardiac ganglia and muscle, and contributes to the final arrest of the circulation.

The **terminations of the vagus in the bronchial walls are paralysed** by atropia, the tension of the muscular coat of the bronchi diminished, and the air current thus facilitated. The **afferent branches of the vagus in the same parts are also paralysed,** thus diminishing sensibility and reflex action, that is, dyspnœa and cough. These effects are in addition to the stimulation of the respiratory centre already noticed.

The **inhibitory branches of the splanchnics** in the *intestinal* walls **are depressed** by atropia, which thus **increases the peristaltic movements,** and causes relaxation of the bowels. It is doubtful whether the ganglia and plexuses, and the muscular coat, are also affected. The vaso-motor fibres of the splanchnics, however, resist atropia.

Atropia appears to affect the terminations of the nerves of the *urethra, bladder,* and *vesiculæ seminales,* but this part of its action is still obscure. Frequent desire and inability to pass water is a symptom of overdoses.

Metabolism and temperature.—Nutritive activity is increased by belladonna, obviously through the increased circulation and respiration; and most of the solid excretions are increased, as will be seen under the urine. The temperature is correspondingly raised; but sinks with the failure of the circulation after large doses.

4. SPECIFIC USES.

From its sedative effect on the *convolutions,* belladonna in full doses has been given in the low delirium of fevers, mania, and alcoholism, especially if opium fail. Neither for this purpose nor as a hypnotic can it be said to be in general use. It has also been recommended in such neuroses as epilepsy, chorea, and megrim; and in some cases relieves the symptoms of these, without effecting a cure.

Belladonna has been given with success in many forms of cord disease, including spasmodic paralysis.

Liquor Atropiæ Sulphatis is extensively instilled into the *eye* as a mydriatic or pupil dilator, for ophthalmoscopic examination, and to prevent or break down adhesions in iritis; also to paralyse accommodation before determining refraction. The routine employment of atropia in all kinds of eye disease is, however, to be deprecated, as it may sometimes precipitate glaucoma. See *Physostigma*, page 228.

Atropia occasionally relieves the *salivation* of mercury, of pregnancy, and of cerebral disease, but is necessarily uncertain, as the pathology of such cases is often obscure.

Belladonna and atropia are greatly used as *anhidrotics* to check the sweats of phthisis, and other hectic conditions. The extract is generally used in pill at bedtime, or the Solution of Sulphate of Atropia when the case can be watched.

Applied in the form of plaster, liniment, or ointment of belladonna, or as a lotion of atropia, this drug is constantly employed as an *anti-galactagogue*, to "dispel the milk" at any period after delivery. It also arrests mammary abscess.

Belladonna is a valuable remedy in some cases of disease of the *heart and vessels*, where the indication is to empty the left ventricle quickly, and relax the vessels, without diminishing the cardiac force. Such cases cannot be further particularised here, but it may be said that belladonna is frequently given, either alone or combined with digitalis, thus securing certain advantages of both drugs, whilst otherwise they may antagonise each other. Belladonna is clinically believed to relieve cardiac pain and palpitation, and is always to be preferred to opium for this purpose; probably this effect is chiefly an indirect one, referable to frequent emptying of the ventricles, lowering of the vascular tension, and prevention of distension of the heart. The plaster, or the extract mixed with glycerine, applied to the præcordium, the extract internally, and atropia subcutaneously, are more trustworthy forms for this purpose than the tincture. A combination of morphia and atropia subcutaneously is especially valuable in cardiac distress. See *Opium: Combinations of Morphia and Atropia*, page 197.

Belladonna is used in diseases of the *respiratory organs*, both for the prevention and for the relief of spasm of the bronchi (asthma), spasmodic cough of any kind, and especially pertussis. It is difficult to over-estimate the value of this drug as a sedative to the respiratory nerves, as compared with opium. The latter also relieves spasm and cough, but tends to paralyse the respiratory centre, and has generally to be avoided. Belladonna soothes the afferent and efferent nerves of the bronchi, but strengthens the respiratory centre, and may be given with great confidence.

Some forms of chronic *constipation* are relieved by belladonna, which is here given as the extract combined usually with aloes. Acute obstruction of the bowels may yield to atropia, with or without morphia. Fissure of the anus and spasm of the sphincter are greatly benefited by its local use as a suppository.

Belladonna is useful in diseases of the *genito-urinary organs*, such as chordee, spermatorrhœa, some cases of retention of urine, the nocturnal incontinence of children, and all forms of painful spasm of the bladder, as in calculus, cystitis, and prostatitis. In these cases it is best given as suppository, or applied to the perinæum.

Belladonna or atropia may be used in *poisoning by opium* (see *Opium*, page 198), and by calabar bean.

5. REMOTE LOCAL ACTION AND USES.

Atropia is excreted unchanged in the urine, almost immediately on its administration: in 10 to 20 hours the last traces have left the body. It increases the urea, phosphates, sulphates, and water, but not the chlorides of the urine; that is, is **diuretic.** It cannot be said to be much used for this purpose. In flowing over the ureters, bladder, and urethra, it may again relieve local pain and spasm, as indicated in the last section.

Stramonii Folia—STRAMONIUM LEAVES.—The dried leaves of Datura stramonium, Thorn Apple. Collected from plants in flower, cultivated in Britain.

Characters.—Large, ovate, sinuous, deeply cut; of a heavy odour, which is strongest while they are drying, and of a mawkish faintly bitter nauseous taste.

Substances resembling Stramonium Leaves: Belladonna Leaves, less wrinkled; Hyoscyamus Leaves, hairy.

Stramonii Semina—STRAMONIUM SEEDS.—The ripe seeds of Datura stramonium.

Characters.—Brownish-black, reniform, flat, rough, in taste feebly bitter and mawkish; inodorous unless bruised, when they emit a peculiar heavy smell.

Composition.—Both leaves and seeds contain a crystalline alkaloid, *daturia*, combined with malic acid. Daturia, $C_{17}H_{23}NO_3$, is a tropate of tropin, that is, is identical with hyoscyamia, and isomeric but not identical with atropia. See *Belladonna*, page 299.

Incompatibles.—Metallic salts, and mineral acids. Daturia is decomposed by caustic alkalies like atropia.

Preparations of Stramonii Semina.

1. **Extractum Stramonii.**—Spirituous, after washing with ether. *Dose*, $\frac{1}{4}$ to $\frac{1}{2}$ gr.
2. **Tinctura Stramonii.**—1 in 8. *Dose*, 10 to 20 min.

ACTION AND USES.

Daturia has an **almost exactly similar action to atropia.** Two points of difference require to be noticed, namely, (1) that the extract of stramonium is more powerful than the extract of belladonna, and (2) that stramonium is more depressant to the nerves of the bronchi. The use of stramonium is almost confined to the treatment of spasmodic affections of the respiratory organs, such as spasmodic bronchitis and asthma. The extract in doses of $\frac{1}{6}$ gr. may be given to prevent or lessen the attacks, and the leaves may be smoked as cigarettes during the paroxysm.

Hyoscyami Folia—HYOSCYAMUS LEAVES.—The fresh leaves, with the branches to which they are attached, of Hyoscyamus niger; also the leaves separated from the branches and carefully dried; gathered from wild, or cultivated British, biennial plants, when about two-thirds of the flowers are expanded.

Characters.—Leaves sinuated, clammy, and hairy. The fresh herb has a strong unpleasant odour and a slightly acrid taste, which nearly disappear on drying. The fresh juice, dropped into the eye, dilates the pupil.

Substances resembling Hyoscyamus: See *Belladonna* and *Stramonii Folia.*

Composition and Incompatibles.—The active principle is *hyoscyamia*, which is identical with daturia, and isomeric with atropia. See *Stramonii Folia*, page 305, and *Belladonnæ Folia*, page 298.

Preparations.

1. **Extractum Hyoscyami.**—A green extract. 20 of the *fresh* leaves in 1. *Dose*, 3 to 6 gr.

From the Extract is prepared:

Pilula Colocynthidis et Hyoscyami, 1 in 3.

2. **Succus Hyoscyami.**—3 of fresh juice to 1 of Spirit. *Dose*, ½ to 1 fl.dr.
3. **Tinctura Hyoscyami.**—1 in 8. *Dose*, 15 to 60 min.

ACTION AND USES.

These **closely agree with the action and uses of belladonna and stramonium.** The special points to be noted in connection with hyoscyamus are as follows: 1. The pharmaceutical preparations of the plant are decidedly weaker in their action, and must be given in larger doses, than those of stramonium. 2. The secondary or calmative effect of the atropaceous plants on the convolutions is more rapid and pronounced with hyoscyamus, which is used in maniacal excitement, and as an anodyne and hypnotic to children. 3. The laxative and carminative effects on the bowel are decided, and hyoscyamus is often combined with purgative pills. 4. The remote local action on the urinary organs is more marked, so that the tincture relieves irritability of the bladder from any cause.

Duboisia (*Not Officinal*).—An alkaloid derived from an Australian plant, Duboisia myoporoides, and identical with Hyoscyamia.

Sulphate of Duboisia, in golden-yellow scales, is more powerful than the atropia salt, and may be used as a mydriatic, in the form of a solution, 1 gr. to the ounce. Stronger solutions are apt to produce general toxic effects.

Homatropin (*Not Officinal*).—A derivative of Atropia. Its action is similar to that of atropia, though weaker.

It is used only in ophthalmic practice, its advantage being, that whilst it acts as promptly though not so energetically as atropia, its effects subside in about one-fourth the time.

Tabaci Folia— LEAF TOBACCO. — The dried leaves of Virginian Tobacco, Nicotiana tabacum. Cultivated in America.

Characters. — Large mottled-brown ovate or lanceolate acuminate leaves, bearing numerous short glandular hairs;

having a peculiar heavy odour and nauseous-bitter acrid taste; yielding, when distilled with solution of potash, an alkaline fluid, which has the peculiar odour of nicotin, and precipitates with perchloride of platinum and tincture of galls. Not manufactured.

Composition.—Tobacco contains a most powerful alkaloid, *nicotin*, and a concrete volatile oil, *nicotianin*, as well as alkaline salts and other less important substances. *Nicotin*, $C_{10}H_{14}N_2$, is a colourless oily-looking fluid, with an irritating odour of tobacco, and an acrid taste. It forms salts with acids, which, like nicotin itself, are readily soluble in water.

Tobacco smoke contains the very smallest trace only of nicotin, or none, but a number of volatile bodies, chiefly *pyridin* compounds, such as *pyridin*, C_5H_5N; *picolin*, C_6H_7N; *lutidin*, C_7H_9N; *collidin*, $C_8H_{11}N$, which have somewhat the same action as nicotin, but less severe. Hydrocyanic and hydro-sulphurous acids, other simpler gases, creasote, etc., also occur in tobacco smoke.

Preparation.

Enema Tabaci.—20 gr. infused in 8 fl.oz. of Boiling Water for one enema.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Tobacco, taken by the mouth, is a **gastro-intestinal irritant**, causing salivation, nausea, vomiting, severe colic, and repeated evacuations. The same effects may follow tobacco smoking, and the application of the leaf to the unbroken skin, or of snuff to the nose. Tobacco smoking and snuffing may thus cause catarrh of the throat and stomach, and promote the movement of the bowels—facts of therapeutical interest. Tobacco is never given by the mouth. Snuff is an errhine.

Injected into the rectum, the Enema rapidly produces peristaltic movements, with expulsion of gas and fæces, and the specific effects now to be described. It has been used in **ileus and constipation.**

2. ACTION IN THE BLOOD.

Nicotin very rapidly enters the blood from all surfaces, but does not directly affect the corpuscles.

3. SPECIFIC ACTION AND USES.

All the organs are quickly reached by nicotin. It acts chiefly upon the **nervous structures**, which it **first stimulates**, if given in very minute doses; but **afterwards depresses** in an extreme degree, causing **intense** and **universal debility**, which, with the local irritation of the alimentary canal, constitute a condition of collapse. On analysis, it is found that tobacco causes pleasing cerebral excitement; decided stimulation of the motor centres in the cord, with a feeling, and true increase, of muscular strength (ending in convulsions and paralysis, in poisonous doses); excitation, followed by paralysis, of the peripheral nerves, both sensory and motor; but no direct effect on the muscles. Respiration is first excited, then disturbed, and finally arrested, death by tobacco being due to arrest of the centre. The action of tobacco on the heart is, contrary to general belief, not directly the cause of death: it is first slowed, then accelerated, and finally weakened with slowing, but it beats after respiratory death. The blood pressure falls, rises, and falls again, with the cardiac action, and from direct central and peripheral effect on the vasor apparatus. The temperature falls.

Tobacco was formerly employed in enema to produce general muscular debility and relaxation, for the reduction of hernia; but chloroform has entirely displaced it. Its depressant effects suggest its use as an antispasmodic in whooping-cough, asthma, hiccup, tetanus and strychnia poisoning, rigidity of the cervix uteri, etc., but such a powerful drug is very seldom employed.

4. REMOTE LOCAL ACTION AND USES.

Nicotin is excreted unchanged in the urine, saliva, and fæces. As a diuretic, it was formerly given in dropsy, but this use of the drug has been abandoned.

SCROPHULARIACEÆ.

Digitalis Folia—DIGITALIS LEAVES.—The dried leaves of Digitalis purpurea. Purple Foxglove. Collected from wild indigenous plants, when about two-thirds of the flowers are expanded.

Characters.—Ovate lanceolate, shortly petiolate, rugose, downy, paler on the under-surface, crenate.

Substance resembling Digitalis Leaves: Matico, which is more deeply reticulated.

Composition.—The active principle of digitalis, known as *digitalinum*, or *digitalin*, occurs in two forms: (*a*) *Homolle* and *Quévenne's digitalin*, a yellowish-white amorphous, or scaly very intensely bitter substance; and (*b*) *Nativelle's digitalin*, in crystalline prisms, also very bitter. It is now known to be a compound of four bodies, namely, (1) *Digitalin* proper, insoluble in water, forming the bulk of Homolle's digitalin ; (2) *Digitaleïn*, very soluble in water ; (3) *Digitoxin*, insoluble in water, and the chief constituent of Nativelle's digitalin ; and (4) *Digitonin*, probably the same as saponin, the active principle of senega. Digitaleïn seems to possess the properties of a mixture of digitalin and digitonin. Digitoxin is by far (7 times) the most powerful, a local irritant, and a muscular depressant ; and therefore, and because insoluble, unfit for use. None of the constituents are so suitable as digitalis leaf itself.

Incompatibles.—Sulphate and tincture of iron, acetate of lead, and preparations of cinchona.

Preparations.

1. **Digitalinum.** Digitalin. — A complex active substance obtained from digitalis. *Source.*—Made from (1) an alcoholic extract, by dissolving out the Digitalin with Acetic Acid and Water ; (2) decolorising with Charcoal ; (3) precipitating the impure Digitalin with Ammonia and Tannic Acid ; (4) removing excess of Tannic Acid by Oxide of Lead ; (5) dissolving in Spirit ; and (6) purifying with Charcoal and Ether. *Characters.*—Porous mamillated masses, or small scales, white, inodorous, and intensely bitter. *Dose,* $\frac{1}{60}$ to $\frac{1}{30}$ gr.
2. **Infusum Digitalis.**—1 in 160. *Dose,* 2 to 4 fl.dr.
3. **Tinctura Digitalis.**—1 in 8. *Dose,* 5 to 30 min.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, digitalis has a slightly irritant action ; it is probably not absorbed by the unbroken skin.

Internally, in full doses, it deranges the stomach and bowels ; dyspepsia, vomiting, and occasionally diarrhœa following its continued use in small doses—effects which are partly local, partly specific, and to be carefully avoided or checked in practice.

2. ACTION IN THE BLOOD AND SPECIFIC ACTION.

The active principles of digitalis enter the blood freely. Thence they reach the tissues more quickly than they leave them ; and doses, however small, if closely repeated, tend to accumulate in the body. **The action of digitalis is mainly**

confined to the circulatory organs, the other parts being chiefly affected secondarily. Both the heart and vessels are influenced by the drug, the action of which occupies *four stages*, the first stage being shortened and the other stages more marked as the dose is increased. In the *first stage*, the heart falls in frequency (say to fifty per minute), from stimulation of the vagus in the heart and medulla; and beats with increased force, from stimulation of the intrinsic ganglia. Therewith the arterial pressure rises, from the increased cardiac force, and from excitation both of the vaso-motor centre and vaso-motor nerves. The result of all this is that the ventricles are well filled (diminished frequency, *i.e.* lengthened diastole); the ventricles are thoroughly emptied (increased force); the arteries are thus well filled; and they are kept filled (vaso-motor action.) The condition is that of a perfect circulation, which **empties the veins and fills the arteries.**

In the *second stage*, the state of the heart remains unchanged, but the vaso-motor apparatus of the renal arteries are rather suddenly depressed; these vessels are relaxed; and the force of the circulation is thus thrown upon them, that is on the glomeruli. The result is **increase in the excretion of urinary water.**

In the *third stage*, the heart rises in frequency, from depression of the vagus, and probably some irritation of the sympathetic (accelerator) fibres; and loses force, from commencing exhaustion of the intrinsic ganglia and muscle. At the same time the arterial pressure falls, from the weakening of the heart, and from depression of the vaso-motor apparatus, which spreads from the kidney, where it commenced, to the other peripheral arterioles. Thus the **circulation begins to fail.**

In the *fourth stage*, the action of the heart becomes irregular, infrequent, and weak, from failure of the ganglia and myocardium; and is finally arrested in diastole. Therewith the blood pressure gradually sinks to zero, from loss of cardiac force and complete paralysis of the vessel walls. **Death occurs by general circulatory failure.**

Respiration fails at last, but only through the circulation. The *voluntary muscles* are paralysed through failure of their blood supply. The *uterus* is said to be stimulated by moderate doses. The *body temperature* is briefly raised through increased vigour of the circulation; it is then lowered by the increased blood-flow in the skin; and falls still more in the last stages, in an irregular uncertain way, from causes still obscure. Digitalis is thus a **refrigerant.** The *central nervous system* is only secondarily affected through the blood supply. Headache, giddiness, disturbance of sight and vision are frequently induced by medicinal doses of digitalis; with a sense of faintness, depression, nausea, or actual sickness. *Metabolism* is variously influenced by digitalis, according to the length of the different stages and the rapidity of their development. When the pressure and temperature are high, the urea and uric acid may be increased, and certain salts may be diminished in amount.

The effect of digitalis on the *urine* is equally uncertain in the healthy individual; the period at which the renal vessels begin to be relaxed, the duration of the second stage, and the relation of the action of the drug on the heart to its action on the vessels, being all variable. As a rule, the urine is not increased in bulk in health, but is remarkably increased in some cases of dropsy to be presently referred to.

3. SPECIFIC USES.

Digitalis is one of the most valuable of medicinal remedies, and is employed in the following conditions:

1. Digitalis is indicated in **disease of the heart**, when the nervo-muscular structures of the cardiac walls fail, so that the circulatory force falls, the cavities are incompletely emptied, the arteries are insufficiently filled, the veins imperfectly drained, and the blood accumulates behind the seat of disease. Such a condition is characterised by cardiac distress and pain; a small, weak, and often irregular pulse; distension of the veins, hæmorrhage, dropsy, and visceral disorder; and often by congestion of the lungs, and great dyspnœa. It occurs under a variety of circumstances which demand separate consideration.

The disturbances of the circulation produced by disease of the *valves* of the heart are removed by a natural process of compensation, consisting of hypertrophy of the muscular walls, with or without dilatation of the cavities. If this compensation do not occur, or fail after having been established, and the circulation be disordered as described, digitalis may give relief, by increasing the force of the cardiac wall; by lengthening diastole, so that the venous flow and the ventricular rest are both prolonged; and by sustaining the pressure on the arteries, thus driving the blood in a steady stream into the veins. All the symptoms will be thus removed, including dropsy, the fluid being absorbed by the increased venous flow, and excreted by the kidneys as a profuse diuresis. Mitral disease, tricuspid incompetence, and aortic obstruction are the forms of valvular disease in which imperfect or failing hypertrophy is relieved by digitalis. In aortic incompetence some authorities forbid the use of the drug, as prolonging diastole, and thus permitting greater reflux, but this practice is not to be carried too far, and digitalis must be given if the ventricle fail. In mild cases, when little more than a tonic effect on the heart is desired, the tincture is prescribed. When dropsy is present, and the patient confined to bed, the infusion or the powdered leaf should be given, and the effect carefully watched. Without nourishing, digestible, and digested food, digitalis can only exhaust the heart, and attention must therefore be paid to the stomach, liver, and bowels. Iron may be combined with advantage, but only after the excretory and digestive functions have been restored. Let it be carefully observed that digitalis is not to be given in a routine fashion for valvular disease, but *with reference to the state of the muscular wall associated with the lesion.* Digitalis is of great service in failure of the heart from *primary* disease of the walls, as in chronic myocarditis; in the granular degeneration of acute myocarditis, pericarditis, and endocarditis, occurring in scarlet fever and acute rheumatism; and in acute alcoholism. In fatty degeneration digitalis may have to be withheld, lest irregular contraction and rupture occur. Digitalis restores the vigour of the heart in failing hypertrophy of *chronic Bright's disease*, when it is breaking down against excessive peripheral resistance; until the heart begins to fail, the drug is contraindicated, but when dilatation begins it must be given. In *functional* or *nervous* palpitation, pain, or irregularity, with debility and dyspepsia, digitalis is often valuable; as also in reflex cases, with gastric disorder, where small doses control the vagus, but must be given intermittently, the dyspeptic effect of the drug also being remembered. Digitalis is harmful in pure *hypertrophy.* In disease of the *right ventricle* from chronic lung disease digitalis is occasionally useful, but fails entirely in some cases. In *exophthalmic goître* it is invaluable combined with quinine and iron. In *cardiac dropsy* digitalis is a thoroughly rational and highly successful remedy. In *renal dropsy* it is of great service, when this is acute, complicating scarlet fever, or due to failure of an hypertrophied heart. In dropsy from chronic tubular nephritis (large white kidney) it is rarely of use, as it has no influence on the renal cells.

Digitalis is used in *hæmorrhage*, but therapeutics is notoriously uncertain here. It will relieve hæmoptysis due to mitral disease, or to the congestion of incipient phthisis in persons with languid circulation. For menorrhagia it may be useful by stimulating the uterine wall, or in the subjects of heart disease.

In secondary bronchial catarrh and acute pneumonia it acts entirely as a cardiac stimulant. Digitalis is but little used by English physicians as an antipyretic in fever, as it is slow, uncertain, dangerous, and unnecessary. Combined with quinia it is exhibited in phthisis, but is apt to derange digestion. Empirically, in doses of several drachms, the tincture has been found useful in *delirium tremens*, but is unquestionably dangerous. Moderate doses are invaluable in the same disease, or in subacute or chronic cases of alcoholism, to stimulate the heart, relieve low sinking feelings, and rouse the appetite.

4. REMOTE LOCAL ACTION.

Traces of some of the active principles of digitalis have been detected in the urine. The action of the drug upon the urine, let it be carefully noted, is not due to any direct influence on the cells of the kidney, but to its effect chiefly on the heart and vessels generally, partly on the renal arteries.

LABIATÆ.

Rosmarini Oleum—OIL OF ROSEMARY.—The oil distilled from the flowering tops of Rosmarinus officinalis.

Characters.—Colourless, with the odour of rosemary, and a warm aromatic taste.

Composition.—Oil of rosemary has the usual composition of its allies, consisting of a terpene, isomeric with turpentine, $C_{10}H_{16}$, and a body allied to camphor.

Dose.—1 to 5 min.

Preparations.

Spiritus Rosmarini.—1 in 50. *Dose*, 10 to 30 min.

Oil of Rosemary is also contained in Linimentum Saponis and Tinctura Lavandulæ Composita.

ACTION AND USES.

Rosemary resembles the other **aromatic** volatile oils in its action and applications. It is a favourite component of stimulating lotions.

Lavandulæ Oleum—OIL OF LAVENDER.—The oil distilled in Britain from the flowers of Lavandula vera.

Characters.—Colourless or pale yellow, with the odour of lavender, and a hot bitter aromatic taste.

Composition.—Oil of lavender is a mixture of a terpene, $C_{10}H_{16}$, and a substance allied to camphor.

Impurities.—Oils of spike and turpentine.

Dose.—1 to 5 min.

Preparations.

1. **Spiritus Lavandulæ.**—1 in 50. *Dose,* ½ to 1 fl.dr.
2. **Tinctura Lavandulæ Composita.**—*Dose,* ½ to 2 fl.dr.

Tinctura Lavandulæ Composita is contained in Liquor Arsenicalis.

Oleum Lavandulæ is an ingredient of Linimentum Camphoræ Compositum.

ACTION AND USES.

Lavender possesses the action of **aromatic** volatile oils in general, and is used in the same way. The tincture is a favourite colouring material for mixtures and lotions.

Menthæ Piperitæ Oleum—OIL OF PEPPERMINT.—The oil distilled in Britain from fresh flowering Peppermint, Mentha piperita.

Characters.—Colourless or pale yellow, with the odour of peppermint; taste warm and aromatic, succeeded by a sense of coldness in the mouth.

Dose.—1 to 5 min.

Menthæ Viridis Oleum—OIL OF SPEARMINT.—The oil distilled in Britain from fresh flowering Spearmint, Mentha viridis.

Characters.—Colourless or pale yellow, with the odour and taste of spearmint.

Dose.—1 to 4 min.

Composition.—Peppermint oil consists of a liquid terpene, and a stearoptene, *peppermint-camphor* or *menthol,* $C_{10}H_{20}O$, in colourless prisms, with the taste and odour of peppermint. Oil of spearmint has probably a similar composition.

Preparations.

A. *Of Peppermint:*

1. **Aqua Menthæ Piperitæ.**—1 in 853, by distillation. *Dose,* 1 to 2 fl.oz.
2. **Essentia Menthæ Piperitæ.**—1 in 5. *Dose,* 10 to 20 min.
3. **Spiritus Menthæ Piperitæ.**—1 in 50. *Dose,* 30 to 60 min.

Oil of Peppermint is also contained in Pilula Rhei Composita.

B. *Of Spearmint :*

Aqua Menthæ Viridis.—1 in 853, by distillation. *Dose*, 1 to 2 fl.oz.

ACTION AND USES.

Peppermint has the action of other **aromatic** volatile oils (see *Caryophyllum*, page 242), and is used accordingly. It is a favourite flavouring agent, with powerful carminative effects.

Menthol, the stearoptene of *Mentha arvensis*, and "Chinese oil of peppermint," have lately been used locally to relieve the pain of rheumatism, neuralgia, and toothache, as possessing in a marked degree the local anæsthetic, vascular stimulant, and disinfectant action of these oils, described under *Terebinthinæ Oleum*. It is of no real value as an antiseptic dressing.

Oleum Thymi—OIL OF THYME. (*Not Officinal.*)—A volatile oil distilled from Thymus vulgaris.

Thymol. — $C_{10}H_{13}HO$ (*Not Officinal*). — A stearoptene contained in Oil of Thyme.

Characters.—Large colourless, transparent crystals with an aromatic thyme-like odour, and an aromatic peppery taste. Solubility, 1 in 800 of water; freely in spirit and caustic alkaline solutions; also in fats and oils.

Dose.—½ to 2 gr.

Non-officinal Preparations.

Thymol Solution.—For antiseptic spray, 1 in 1000.
Thymol Gauze.—Contains 1 per cent. of thymol.
Thymol Ointments.—Contain 5 to 30 gr. in 1 oz.

ACTION AND USES.

Thymol is an **antiseptic** and **disinfectant**, extensively used in the Listerian system.

HAMAMELACEÆ.

Hamamelis. (*Not Officinal.*)—The leaves of Hamamelis virginica, the Witch Hazel, collected in autumn. From the United States.

Characters.—Short petiolate, 4 inches long, obovate or oval, oblique at base, sinuate-toothed, nearly smooth; inodorous; astringent and bitter.

Composition.—Hamamelis contains traces of *tannic acid*, odorous matters, etc. Its active principle appears to be unknown.

Non-officinal Preparations.

Hamamelin, a powdered Extractive; *Dose*, ½ to 2 gr. Tincture (1 to 10); *Dose*, 2 to 5 min. Fluid Extract (1 in 1); *Dose*, 10 min. to 2 fl.dr.

ACTION AND USES.

Hamamelis is an **astringent** and **hæmostatic** both locally and remotely, useful in hæmorrhages from the nose, lungs, rectum, or uterus.

POLYGONACEÆ.

Rhei Radix—RHUBARB ROOT.—The dried root deprived of the bark, from one or more undetermined species of Rheum. From China, Chinese Tartary, and Thibet. Imported from Shanghai and Canton.

Characters.—Trapezoidal, roundish, cylindrical, or flattish pieces, frequently bored with one hole, yellow externally, internally marbled with fine waving greyish and reddish lines, finely gritty under the teeth; taste bitter, faintly astringent and aromatic; odour peculiar.

Composition.—The active purgative principle of rheum is probably identical with *cathartic acid*, the purgative constituent of senna. With this is combined *rheo-tannic* acid, possessing astringent properties. The yellow colouring matter is *chrysophanic acid* in small quantity; now made from araroba, and used for other purposes. (*See* page 231.) *Chrysophan*, $C_{16}H_{18}O_8$, is a yellow crystalline bitter glucoside. *Emodin*, *phæoretin*, and *oxalate of lime* (35 per cent.) are less important constituents.

Impurities.—English rhubarb, known by taste, odour, and excess of starch. Turmeric, reddened by boracic acid.

Dose.—As a stomachic, 1 to 5 gr.; as a purgative, 10 to 20 gr.

Preparations.

1. **Extractum Rhei.**—Spirituous. 100 in 39. *Dose*, 3 to 10 gr.
2. **Infusum Rhei.**—1 in 40. *Dose*, 1 to 2 fl.oz.
3. **Pilula Rhei Composita.**—Rhubarb, 3 oz.; Socotrine Aloes, 2¼ oz.; Myrrh, 1½ oz.; Hard Soap, 1½ oz.; Oil of Peppermint, 1½ fl.dr.; Treacle, 4 oz. *Dose*, 5 to 10 gr.
4. **Pulvis Rhei Compositus.**—"Gregory's Powder." Rhubarb, 2; Light Magnesia, 6; Ginger, 1. *Dose*, ½ to 1 dr.

5. **Syrupus Rhei.**—*Dose,* 1 to 4 fl.dr.
6. **Tinctura Rhei.**—1 in 10. *Dose,* as a stomachic, 1 to 2 fl.dr.; as a purgative, ½ to 1 fl.oz.
7. **Vinum Rhei.**—1 in 14. *Dose,* 1 to 2 fl.dr.

All preparations, excepting the Extract and Infusion, are compound.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

The action of rhubarb is confined to the alimentary canal. In small doses (1 to 5 gr.), the bitter principle and rheo-tannic acid are chiefly active, as **bitter stomachics and intestinal astringents.** In larger doses (up to 40 gr.) the cathartic acid exerts its influence before the rheo-tannic acid; **stimulates the intestinal movements and liver,** as in senna, with some griping; and causes **purgation,** producing in six to eight hours a liquid motion, of a yellow colour from the pigment of the rhubarb and excess of bile. The cathartic acid being expelled, the effect of the tannic acid becomes evident, and the bowels are confined.

Rhubarb is used in small doses as a bitter stomachic, intestinal astringent, and tonic, to correct atonic indigestion with diarrhœa, as in dyspeptic and rickety infants and children. Larger doses are given as a purgative, in the form of the Compound Powder, to sweep out the bowels and then set them at rest, in cases of summer diarrhœa and *diarrhœa ab ingestis* of children, combined sometimes with a mercurial. The Compound Pill is a familiar mild laxative for habitual use, suiting some persons, but demanding constant repetition in the majority. The cholagogue action of rhubarb adds to its value both in stomachic and purgative preparations. Its griping effect must be remembered, and the drug should never be given alone.

3. ACTION IN THE BLOOD, SPECIFIC, AND REMOTE LOCAL ACTION.

The chrysophan and chrysophanic acid, at least, are absorbed into the blood, pass through the tissues, and are thrown out in the secretions, which they stain yellow, including the urine.

MYRISTICACEÆ.

Myristica—NUTMEG.—The kernel of the seed of Myristica officinalis. Cultivated extensively in the Banda Islands of the Malayan Archipelago.

Characters.—Oval or nearly round, about an inch in length, marked externally with reticulated furrows, internally greyish-red with dark-brownish veins. It has a strong peculiar odour, and a bitter aromatic taste.

Substance resembling Nutmeg: Areca, without odour.

Composition.—Nutmeg and mace contain about 30 per cent. of the officinal *concrete oil*, 4 to 9 per cent. of the officinal *volatile oil*, starch, etc. The *concrete* oil is a compound of (fluid) glycerides of oleic and butyric acids, and the solid glyceride of *myristic acid*, $C_{14}H_{28}O_2$, a little volatile oil, and resin. The *volatile* oil of nutmeg consists chiefly of a terpene, and an oxygenated oil, *myristicol.*

Preparations.

1. **Myristicæ Oleum Expressum.**—The concrete oil, obtained from nutmegs by expression and heat. Orange-coloured, with the odour of nutmeg.

From Myristicæ Oleum Expressum are prepared:

Emplastrum Calefaciens and Emplastrum Picis.

2. **Myristicæ Oleum.**—The volatile oil distilled in Britain from nutmegs. Colourless, fragrant. *Dose*, 2 to 6 min.

From Myristicæ Oleum is prepared:

Spiritus Myristicæ.—1 in 50. *Dose*, 30 to 60 min.

Nutmeg and the volatile oil are also contained in many preparations of more important drugs.

ACTION AND USES.

The solid oil has the **local stimulant** action of volatile oils, and is used as an inunction, or in plasters, to relieve the pain and swelling of chronic rheumatism, etc. The volatile oil resembles its many allies, and is chiefly used for culinary purposes.

LAURACEÆ.

Cinnamomi Cortex—CINNAMON BARK.—The inner bark of shoots from the truncated stocks of Cinnamomum zeylanicum. Imported from Ceylon, and distinguished in commerce as Ceylon Cinnamon.

Characters.—About one-fifth of a line thick, in closely-rolled quills, which are about four lines in diameter, containing several small quills within them, light yellowish-brown, with a fragrant odour and warm sweet aromatic taste: breaks with a splintery fracture.

Impurity : Cassia bark, rougher, thicker, less aromatic.

Composition.—Cinnamon bark contains the officinal *oil*, as well as *tannic acid*, *starch*, *sugar*, and *gum*. The oil is readily converted by exposure to air into cinnamic aldehyd, C_9H_8O, and cinnamic acid, $C_9H_8O_2$. See *Styrax*, page 334, and *Balsamum Peruvianum*, page 226.

Dose.—10 to 20 gr.

Preparations.

1. **Aqua Cinnamomi.**—1 in 8. *Dose*, 1 to 2 fl.oz.
2. **Oleum Cinnamomi.**—The oil distilled from cinnamon. Yellowish when recent, becoming red. *Dose*, 1 to 4 min.
3. **Pulvis Cinnamomi Compositus.**—Cinnamon, 1 ; Cardamoms, 1 ; Ginger, 1. *Dose*, 3 to 10 gr.
4. **Tinctura Cinnamomi.**—1 in 8. *Dose*, ½ to 2 fl.dr.

Cinnamon is also contained in a large number of preparations of other more important drugs, including the compound powders of Catechu, Chalk, and Kino.

ACTION AND USES.

Cinnamon, besides possessing the same action, and being used for the same purposes, as other **aromatic** substances (see *Caryophyllum*, page 242), has moderately **astringent** properties by virtue of its tannic acid. It is therefore the favourite flavouring and carminative agent in astringent powders, tinctures, etc. These are chiefly used in diarrhœa.

Camphora—CAMPHOR.—A concrete volatile oil, obtained from the wood of Camphora officinarum. Imported in the crude state from China and Japan, and purified by sublimation in this country.

Characters and test.—White, translucent, tough, and crystalline ; has a powerful penetrating odour, and a pungent taste followed by a sensation of cold ; floats on water ; volatilises slowly at ordinary temperatures ; is slightly soluble in water, but readily soluble in rectified spirit and in ether, or when mixed with carbolic acid, chloral-hydrate, or thymol. It can be powdered by being rubbed with a few drops of spirit. Sublimes entirely when heated.

Composition.—Camphor is a solid volatile oil or stearoptene, with the composition $C_{10}H_{16}O$. Borneo Camphor or Baros Camphor, sometimes substituted for Japanese camphor, has the formula $C_{10}H_{18}O$, *i.e.* bears the same relation to Japanese camphor as alcohol to aldehyd.

Impurities.—Borneo camphor, which sinks in water. Fixed salts, left on sublimation.

Dose.—1 to 10 gr.

Preparations.

1. **Aqua Camphoræ.**—About ½ gr. in 1 fl.oz. *Dose,* 1 to 2 fl.oz.
2. **Linimentum Camphoræ.**—1 to 4 of Olive Oil.
3. **Linimentum Camphoræ Compositum.**—1 in 9, with Strong Solution of Ammonia, Spirit, and Oil of Lavender.
4. **Spiritus Camphoræ.**—1 in 10. *Dose,* 10 to 30 min. (in milk or on sugar; an irritant preparation).
5. **Tinctura Camphoræ Composita.** — "Paregoric Elixir." Camphor, 30 gr.; Opium, 40 gr.; Benzoic Acid, 40 gr.; Oil of Anise, ½ dr.; Proof Spirit, 20 fl.oz. 1 fl.dr. contains ¼ gr. opium. (See *Opium,* p. 183.) *Dose,* 15 to 60 min.

Camphor is also contained in all except four liniments, and in two ointments.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Camphor closely resembles other aromatic oils in its action, as described under *Terebinthinæ Oleum,* page 343. It is (1) weakly **antiseptic**; (2) **stimulating to the local circulation**; **and** (3) **sedative to the nerves, after preliminary stimulation.** The uses of camphor externally depend on these properties: the many liniments and ointments which contain it are intended to increase the nutrition of indurated or stiffened parts, to relieve pain, or to produce counter-irritation. The fluid compounds with carbolic acid, chloral, thymol, etc., are valuable anodynes.

Internally.—Camphor combined with carbolic acid forms an antiseptic and anæsthetic dressing for carious teeth. In the mouth it produces its peculiar taste, increase of the local circulation, salivation, and mucous flow. Reaching the stomach, it causes a sense of warmth; is a weak antiseptic; and again acts like turpentine. Briefly, it is a **carminative**, its purely local action stimulating digestion and relieving flatulence, and its reflex effects being visible in increased action of the heart, fulness and force of the pulse, and cerebro-spinal excitation. Its carminative properties, whilst generally applicable, are specially valuable in hysterical vomiting.

The intestinal effects of camphor are very similar, and it is therefore useful in some forms of diarrhœa, in the first stage of cholera, and in meteorism.

2. ACTION ON THE BLOOD.

Camphor enters the blood freely from the unbroken skin and mucous surfaces, and is found in it unchanged.

3. SPECIFIC ACTION AND USES.

In the organs and tissues a portion of the camphor administered is found unchanged; the rest appears to combine with glucose. The nervous system is chiefly affected by this drug, which in doses above those usually ordered may so act on the cerebrum as to produce a kind of **intoxication**, with confusion of mind, speech, gait, and gesture, and thereupon convulsions, probably originating in the medulla. Moderate doses are said to produce an aphrodisiac, followed by an anaphrodisiac, effect. Camphor has accordingly been used in nervous prostration, especially towards the end of acute specific fevers, such as typhoid; in poisoning by opium and other narcotics; in alcoholism, including delirium tremens; and in various nervous disorders, dependent probably on disturbance of the cerebral and spinal centres, such as insanity, hysteria, whooping cough, chordee or priapism, spermatorrhœa, etc. In large doses of particular preparations, and probably on certain subjects, instead of excitement camphor produces rapid depression, chiefly referable to the heart, namely, failure of the pulse, pallor, coldness and moistness of the surface, impaired local sensibility, and unconsciousness. The respiration is much disturbed after full doses, in association with convulsions and coma. Moderate doses, as we have seen, stimulate the heart reflexly from the stomach. The effect of camphor on metabolism is unknown; it lowers the body temperature both in health and in pyrexia, an action which may contribute to its value in fevers.

4. REMOTE LOCAL ACTION AND USES.

Camphor is excreted unchanged by the respiratory organs, on which it probably acts like turpentine, and is a common ingredient of **expectorant** mixtures, especially as the Compound Tincture. The skin also throws out camphor, which increases and gives its odour to the perspiration, the effect being **refrigerant**, and probably accounting for the use in common colds of the homœopathic solution, "spirit of camphor," which is a very powerful preparation, occasionally causing death. The kidneys do not excrete camphor as such, but as a complex product.

Sassafras Radix—SASSAFRAS ROOT.—The dried root of Sassafras officinale. From North America.

Characters.—In branched pieces, sometimes eight inches in diameter at the crown; bark externally greyish-brown, internally rusty-brown; of an agreeable odour, and a peculiar aromatic warm taste; wood light, porous, greyish-yellow, more feeble in odour and taste than the bark. Also in chips.

Composition.—Sassafras contains a *volatile oil*, consisting of a turpentine and a camphor; a resin; and a neutral crystalline body, *sassafrin.*

Sassafras is contained in Decoctum Sarsæ Compositum.

ACTION AND USES.

The physiological action of sassafras is unknown. The drug is rarely used alone, but in the Compound Decoction of Sarsaparilla. It is supposed to increase the action of the skin and kidneys in syphilis, rheumatism, etc., and thus to be an **alterative.** See *Sarsæ Radix*, page 354.

Nectandræ Cortex—BEBEERU BARK.—The bark of Nectandra Rodiæi, the Greenheart Tree. Imported from British Guiana.

Characters.—In large flat heavy pieces, from one to two feet long, from two to six inches broad, and about a quarter of an inch thick. External colour greyish-brown; internal colour dark cinnamon-brown. Taste strongly and persistently bitter, with considerable astringency.

Composition.—The active principle of bebeeru bark is *beberia* or *biberin*, $C_{36}H_{40}N_2O_6$, a bitter alkaloid, the sulphate of which is officinal. It also contains tannin.

From Nectandræ Cortex is made:

Beberiæ Sulphas ($C_{36}H_{40}N_2O_6.H_2SO_4$).—The sulphate of an alkaloid prepared from Bebeeru Bark.

Source.—Made by (1) exhausting the powdered Bark with Water and Sulphuric Acid; (2) precipitating the colouring matter with Lime; (3) filtering and precipitating impure Beberia by Ammonia; (4) making a tincture, and therefrom a solution in Diluted Sulphuric Acid; (5) purifying and evaporating to dryness.

Characters.—Dark-brown thin translucent scales; yellow when in powder; with a strong bitter taste. Solubility, 1 in 80 of water; sparingly in spirit.

Incompatibles.—Alkalies and their carbonates, bromide and iodide of potassium, lime-water, tartaric acid and tartrates astringent infusions and tinctures.

Dose.—1 to 10 gr.

ACTION AND USES.

Bebeeru bark is an **aromatic bitter, stomachic and tonic** in its effects, like orange and cascarilla; the alkaloid possesses the properties of a pure bitter.

Like all other substances of this class, beberia is antiseptic, and to a small extent **antipyretic and antiperiodic**; but these effects being comparatively insignificant, its use in fever and ague has now been abandoned.

ARISTOLOCHIÆ.

Serpentariæ Radix—SERPENTARY ROOT.—The dried rhizome of Aristolochia Serpentaria. From the southern parts of North America.

Characters.—A small roundish rhizome, with a tuft of numerous slender rootlets, about three inches long, yellowish; of an agreeable camphoraceous odour, and a warm bitter camphoraceous taste.

Composition.—Serpentary contains chiefly a *volatile oil* and *resin*, with some *bitter* principle.

Preparations.

1. **Infusum Serpentariæ.**—1 in 40. *Dose,* 1 to 2 fl.oz.
2. **Tinctura Serpentariæ.**—1 in 8. *Dose,* ½ to 2 fl.dr.

ACTION AND USES.

Serpentary possesses **local and general stimulant and tonic** properties, closely resembling those of valerian and cascarilla. It is occasionally used in low, nervous, despondent, and excitable conditions, as well as in low fevers and febrile states.

THYMELACEÆ.

Mezerei Cortex—MEZEREON BARK.—The dried bark of Daphne Mezereum, Mezereon; or of Daphne Laureola, Spurge Laurel. British; the latter cultivated.

Characters.—In strips or quilled pieces of various lengths, tough and pliable, olive-brown on the surface, white within, fibrous, odour faintly nauseous, taste hot and acrid.

Composition.—Mezereon contains an acrid *resin*, which is the anhydrid of a resinous acid *mezereinic acid;* an inert *fixed oil;* and a glucoside *daphnin*, also probably inactive.

Preparations.

Extractum Mezerei Æthereum.—8 gr. to 1 fl.oz.

From Extractum Mezerei Æthereum is prepared:

Linimentum Sinapis Compositum.

Mezereum is also an ingredient of Decoctum Sarsæ Compositum. 60 gr. in 1 pint.

ACTION AND USES.

Mezereon is a powerful **local irritant**, like cantharis or mustard, **causing vesication.** Internally it is a stimulant and diaphoretic; it is in large doses an irritant poison. It is not employed alone, the ethereal extract being an ingredient of Linimentum Sinapis Compositum, and the internal use of the drug confined to Decoctum Sarsæ Compositum as an **alterative**, in syphilis, chronic rheumatism, and skin diseases.

EUPHORBIACEÆ.

Cascarillæ Cortex—CASCARILLA BARK.—The bark of Croton Eluteria. From the Bahama Islands.

Characters.—In quills, two or three inches in length, and from two to five lines in diameter, dull brown, but more or less coated with white crustaceous lichens; breaks with a short resinous fracture; is warm and bitter to the taste; and emits a fragrant odour when burned.

Substance resembling Cascarilla: Pale Cinchona Bark, which is less white, smooth, and small.

Composition.—Cascarilla contains a complex mixture of *aromatic oils and resin*, a crystalline bitter principle, *cascarillin*, and some tannin, etc.

Incompatibles.—Lime-water, metallic salts, mineral acids.

Preparations.

1. **Infusum Cascarillæ.**—1 in 10. *Dose*, 1 to 2 fl.oz.
2. **Tinctura Cascarillæ.**—1 in 8. *Dose*, ½ to 2 fl.dr.

ACTION AND USES.

Cascarilla acts in virtue of the aromatic oils and the bitter principle which it contains. It is a pleasant and useful **aromatic bitter stomachic**, but is somewhat difficult to dispense, as the infusion readily decomposes, and the resin separates from the tincture when prescribed with acids.

Oleum Crotonis—CROTON OIL.—The oil expressed from the seeds of Croton Tiglium.

Characters of the seeds.—About the size of a grain of coffee, oval or oval oblong, dull brownish-grey, without odour.

Substance resembling Croton Oil Seed: Castor Oil Seed, which is larger, bright, polished, and marbled.

Characters of the oil.—Slightly viscid; colour brownish-yellow; taste acrid; odour faintly nauseous.

Composition.—The active principle of croton oil is *crotonic acid*, $C_9H_{11}O_2$, a fatty acid, partly free, partly combined with glycerine. With this there are present many *fixed oils* (oleic, palmitic, stearic, myristic and lauric) as well as their free acids; and several *volatile acids* (1 per cent. in all), which give its odour to croton oil, viz. acetic, butyric, baldriac and tiglic acids, and are derived from the fixed oils after extraction only.

Impurities.—Other fixed oils.

Dose.—½ to 1 min. placed on the tongue or in crumb of bread.

Preparation.

Linimentum Crotonis.—1 in 8, with Oil of Cajuput.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Croton oil is a **powerful irritant** to the skin, causing a burning sensation and redness, followed by a crop of papules, and finally severe pustules, which last for days, heal by scabbing, and may leave unsightly cicatrices. Croton oil liniment is much less used than formerly as a counter-irritant in affections of internal parts, especially the lungs and joints.

Internally, also, croton oil is a powerful irritant, causing burning in the throat, heat in the epigastrium, possibly nausea, and purgation. It acts as a very rapid **drastic cathartic**, with some pain, producing a motion within 1 to 2 hours, which is partly solid, the effect being repeated several times during the next twelve hours in a more liquid form. The irritant effect consists chiefly in direct inflammation of the mucous membrane, with increased watery transudation, heightened peristaltic action, probably glandular (not biliary) hypersecretion. The muscular excitement, and consequent griping which it produces, commence before the oil has reached the duodenum, to be acted on by the pancreatic juice and bile, and are, therefore, partly reflex acts, originating in irritation of the gastric nerves by the free portion of the crotonic acid, section of the vagi postponing its purgative action. This accounts for the rapid action of the drug.

Croton oil is used when a speedy and complete evacuation of the bowels, and diminution of the arterial pressure, are demanded. It is a proper purgative in some cases of apoplexy; in intestinal obstruction from impacted fæces; or where other purgatives have failed in constipation, and an organic obstacle does not exist. The smallness of the dose, which can be put in food, renders it a convenient purgative for insane and unconscious patients. Croton oil must always be given with great care; and is inadmissible in feeble subjects, in organic obstruction, and in inflammatory states of the stomach and intestines.

2. ACTION IN THE BLOOD; SPECIFIC, AND REMOTE LOCAL ACTION.

Crotonic acid, or its products, are occasionally absorbed, and cause disturbance of the heart and nervous centres.

Oleum Ricini—CASTOR OIL.—The oil expressed from the seeds of Ricinus communis. Imported chiefly from Calcutta.

Characters of the seeds.—Oval, somewhat compressed, smooth and shining, grey, marbled with reddish-brown or blackish-brown spots and stripes.

Substance resembling Castor Oil Seed: Croton Oil Seed (q.v.).

Characters of the oil.—Viscid, colourless, or pale straw yellow, having a slightly nauseous odour and a somewhat acrid taste. Entirely soluble in one volume of alcohol and in two volumes of rectified spirit.

Composition.—The bulk of castor oil consists of *ricinoleic acid*, $C_{18}H_{34}O_3$, combined with glycerine. Palmitin, stearin, cholesterin, and possibly a resin and an alkaloid also occur in small quantities.

Dose.—1 to 8 fl.dr.

Preparations.

Oleum Ricini is contained in: Collodium Flexile (1 in 49), Linimentum Sinapis Compositum (1 in 9), and Pilula Hydrargyri Subchloridi Composita (1 in 5).

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, pure castor oil is bland, like almond oil; and is applied as a local sedative and protective, for instance, in injury of the conjunctiva by quicklime.

Internally.—Castor oil is perfectly non-irritant if pure, until it reaches the duodenum, where it is decomposed by the pancreatic juice, and the ricinoleic acid at once comes into action. If the oil be rancid, irritation of the stomach will cause nausea and vomiting.

Castor oil is a **simple purgative,** at once rapid and certain, mild and painless, producing one or more liquid but not watery stools in four to six hours, **followed by a sedative effect.** It is believed to stimulate the muscular coat and intestinal glands, but not the liver. It also purges when given as enema.

Castor oil is used as the best of all simple purgatives when a free evacuation of the bowels only is desired. It can be given in all conditions where a laxative is permissible, and is therefore specially employed in the treatment of diarrhœa due to the presence of indigestible or undigested food in the bowels, in the constipation of typhoid fever, after abdominal operations, in pregnancy, and *post-partum.* It is a valuable purgative for children and for the old and infirm. In some forms of indigestion in infants, and of chronic obstruction of the bowels, small doses (5 min. for an infant), may be given three or four times a day for days or even weeks, as an emulsion, with the best result. Small doses of tincture of opium are sometimes combined with castor oil.

2. ACTION ON THE BLOOD; SPECIFIC, AND REMOTE LOCAL ACTION.

Ricinoleic acid enters the blood and tissues, and leaves the body in the excretions, including the milk, which purges the infant at the breast.

The *Leaves* of the Castor Oil Tree, applied locally to the mamma as a poultice, are said to be galactagogue.

Kamala—KAMALA.—A powder which consists of the minute glands that cover the capsules of Rottlera tinctoria. Imported from India.

Characters.—A fine granular mobile brick-red powder, with little odour or taste; difficult to mix with water; mainly soluble in alcohol and ether, the residue consisting principally of tufted hairs.

Impurities.—Sand or earth. *Resembles* Oxide and Iodide of Mercury, but is not heavy.

Composition.—Kamala contains an active resin, *rottlerin,* allied to coussin (see *Cusso*), *tannin,* red colouring matter, etc.

Dose.—30 gr. to ¼ oz., as an electuary with tamarinds.

ACTION AND USES.

Kamala is an **anthelmintic** and slight gastro-intestinal irritant, sometimes causing nausea, vomiting, colic, and diarrhœa. It is used to expel the tape-worm, lumbricoid, and oxyuris.

PIPERACEÆ.

Piper Nigrum—BLACK PEPPER.—The dried unripe berries of Piper nigrum. Imported from the East Indies.

Characters.—Small, roundish, wrinkled; tegument brownish-black, containing a greyish-yellow globular seed. Odour aromatic. Taste pungent, and bitterish.

Substances resembling Black Pepper: Pimento, which has calyx; Cubebs, which has stalk.

Composition.—Pepper contains a *volatile oil*, isomeric with turpentine, with the odour of pepper; a complex *resin;* a tasteless crystalline alkaloid, *piperin*, $C_{17}H_{19}NO_3$, that is, isomeric with morphia; and *chavicin.*

Dose.—5 to 20 gr.

Preparation.

Confectio Piperis.—1 in 10. *Dose*, 1 to 2 dr.

Pepper is also contained in Confectio Opii (1 in 31), and Pulvis Opii Compositus (1 in 7½).

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally, pepper is a domestic rubefacient, anodyne, and counter-irritant, like mustard.

Internally, it acts as a local **stimulant aromatic** in the mouth, stomach, and intestine. As a familiar condiment, it assists gastric digestion like other substances of the same class.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION AND USES.

The volatile oil of pepper acts on the blood and tissues like its allies. Piperin is believed to possess the antiperiodic and antipyretic action of other alkaloids such as quinia; and pepper was once a domestic remedy for ague, which may still be used when the appetite fails.

3. REMOTE LOCAL ACTION AND USES.

Some of the constituents of pepper are excreted by the kidney, and probably by the intestinal mucous membranes, and act as **remote local stimulants of the** circulation and nutrition in the **urethra and rectum.** Pepper is occasionally used in gleet; but much more extensively for hæmorrhoids and other diseases of the rectum.

Cubeba—CUBEBS.—The dried unripe fruit of Cubeba officinalis. Cultivated in Java.

Characters.—The size of black pepper, globular, wrinkled, blackish, supported on a stalk of rather more than its own length; has a warm camphoraceous taste and characteristic odour.

Substances resembling Cubebs: Pimento and Black Pepper, which have no stalk.

Composition.—Cubebs consists of 6 to 15 per cent. of the officinal *volatile oil;* 2 per cent. of a neutral, odourless, and tasteless body, insoluble in water, *cubebin*, $C_{10}H_{10}O_3$; 6 per cent. of a *resin* containing *cubebic acid;* a fatty oil; and gum. Volatile oil of cubebs, $C_{15}H_{24}$, is colourless or pale greenish-yellow, smelling of cubebs.

Dose.—30 to 120 gr.

Preparations.

1. **Oleum Cubebæ.**—The oil distilled in Britain from Cubebs. *Dose*, 5 to 20 min., with mucilage and syrup.
2. **Tinctura Cubebæ.**—1 in 8. *Dose*, ½ to 2 fl.dr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

The action of cubeb pepper closely resembles that of common pepper, but different parts of the body are affected in different degrees.

Cubebs is an aromatic stomachic, in small doses; in large doses it is apt to derange the digestion; and in very large doses it is a gastro-intestinal irritant. It is sometimes applied to the pharynx in chronic inflammation, and very rarely it is given in chronic dyspepsia.

2. ACTION ON THE BLOOD, AND SPECIFIC ACTION.

The active principles of cubebs enter the *blood*, and thence the *tissues*. Large doses probably have an action similar to turpentine, but no use is made of it on this account.

3. REMOTE LOCAL ACTION.

The principal effects of cubeb pepper are produced when it is leaving the body by the kidneys and urinary passages, the skin, and the respiratory organs. In this respect it closely resembles copaiba, and is used in the same class of cases with it. Thus, it is a **diuretic**, acting directly on the renal cells. The cubebic acid is excreted in the urine as a salt, from which it may be precipitated by nitric acid; and **stimulates and disinfects** the **genito-urinary passages** with which it **comes in contact**. The sweat and the bronchial mucus are both increased, and sometimes an eruption appears on the skin.

Cubebs is rarely used except in gonorrhœa and vesical affections. It is decidedly less unpleasant than copaiba, and much less liable to disturb digestion. It is sometimes prescribed for chronic bronchitis.

Maticæ Folia—MATICO LEAVES. —The dried leaves of Artanthe elongata. Imported from Peru.

Characters.—From two to eight inches long, veined and tesselated on the upper surface, downy beneath; with an aromatic, slightly astringent, warm taste, and an agreeable aromatic odour.

Substance resembling Matico: Digitalis. (*See* page 309.)

Composition.—Matico contains a quantity of *volatile oil*, *artanthic acid* (crystalline), *resin*, and *tannic acid*.

Preparation.

Infusum Maticæ.—1 in 20. *Dose*, 1 to 4 fl.oz.

ACTION AND USES.

Matico is said to **resemble pepper and cubebs** very closely in its action, and has been given in the same class of cases, but is not in general use. The physical character of the under surface of the leaf renders it a **local hæmostatic** when applied to incised wounds, as it facilitates coagulation.

SALICACEÆ.

Salicis Cortex—WILLOW BARK. (*Not Officinal.*) —The bark of Salix caprea, and other species.

Characters.—Quilled pieces, the epidermis dark, the structure fibrous and tough; odour slightly aromatic; taste bitter and astringent.

Composition.—Willow bark contains *salicin*, *tannic acid*, and the ordinary constituents of barks.

Non-officinal Preparations.

1. **Salicinum.**—Salicin, $C_{13}H_{18}O_7$. A neutral principle in silky acicular crystals, or white tables; odourless, bitter. Solubility, 1 in 20 of water. *Dose*, 5 to 30 gr.
2. **Acidum Salicylicum,** $C_7H_6O_3$, or $H_2.C_7H_4O_3$. *Source.*—Prepared from the oil of Gaultheria procumbens (Winter Green), or commercially by passing a stream of Carbonic Acid over a heated mixture of Carbolic Acid and Caustic Soda, decomposing by Hydrochloric Acid, and purifying.
   Characters.—Light acicular crystals; odourless, but irritant to the nostrils; with a sweetish taste. Solubility, 1 in 760 water; 1 in 4 of spirit.
   Dose.—5 to 30 gr. or more.

   From Acidum Salicylicum is prepared:

   Sodæ Salicylas, $Na_2.C_7H_4O_3$. *Source.*—Made by neutralising the Acid by Bicarbonate of Soda in water; or as the acid without the final decomposition.
   Characters.—Shining silky tabular crystals, or a white crystalline powder, odourless, with a sweetish unpleasant taste. Solubility, 1 in 1 of water.
   Dose.—10 to 30 gr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Salicylic acid acts as an **antiseptic and disinfectant,** not inferior to carbolic acid. At the same time it stimulates the local circulation. It is extensively used as a surgical dressing in the form of cotton wool impregnated with the acid by the aid of glycerine. On the contrary, salicylate of soda has no antiseptic or disinfectant power, unless combined with a mineral acid to liberate the salicylic acid. Salicylic acid in powder, diluted with talc, is a **anhidrotic,** checking local perspirations of the feet, or the general perspirations of phthisis. Neither substance is absorbed by the unbroken skin.

Internally.—Salicylic acid causes sneezing and cough when applied to the nose, or inhaled, like benzoic acid; and when admitted to the stomach, it is also a local irritant, causing heat, pain, nausea, and vomiting, unless in moderate and well-diluted doses. The soda salicylate is very much less irritant, and may be freely administered if pure. The latter drug is used for sarcinous vomiting, and in some cases of chronic dyspepsia with decomposition. Salicin is easily borne by the stomach. In the bowel it is converted into saligenin ($C_7H_8O_2$) and glucose;

and the former is in turn broken up into salicyluric ($HC_9H_8NO_4$), salicylic, and salicylous acids ($C_7H_6O_2$). Salicylous acid is a local irritant.

2. ACTION ON THE BLOOD AND ITS USES.

Salicylic acid necessarily exists in the blood as the salicylate of soda, being taken up with considerable rapidity. The acid is possibly again liberated in part by the free carbonic acid of the plasma in inflamed parts of the body, and thus exerts its antiseptic action within the body; but this is doubtful. Either in the blood, or in some of the tissues, a portion unites with glycocoll (just like benzoic acid), and forms salicyluric acid (comparably with hippuric acid), thus: $C_7H_6O_3 + C_2H_5NO_2$ (glycocoll) $= H.C_9H_8NO_4$ (salicyluric acid) $+ H_2O$.

As regards salicin, the decomposition begun in the bowel is continued in the blood.

3. SPECIFIC ACTION AND USES.

The action of salicylic acid and its sodium salt is identical in the tissues, since the former is converted into the latter. A moderate dose causes increased cardiac action, flushing and warmth of the surface, perspiration, a full feeling in the head, tinnitus, deafness, impairment of vision, and possibly a **slight fall of temperature,** although the nitrogenous waste is said to be increased. Larger doses may cause delirium. Respiration is temporarily disturbed; the heart is depressed after the primary excitation; the vessels are relaxed, and the blood pressure falls; perspiration is increased; the peripheral nerves, both sensory and motor, are unaffected.

All these phenomena in the healthy subject, taken together, do not account for the remarkable effect of salicylates upon the body temperature in pyrexia or fever. Of all antipyretics these appear to be the most powerful, two or more moderate doses (15 to 20 gr.) within one or two hours **reducing pyrexial temperatures several degrees,** according to the disease and the subject. It is therefore probable that the salicylates act upon some *pathological* cause of pyrexia, possibly the organisms of the specific fevers.

Salicylate of soda is employed in two allied but distinct classes of cases: 1. In pyrexia from any cause, such as typhoid fever, pneumonia, pyæmia, etc., it is a simple and powerful **antipyretic.** In this respect it is comparable with quinia; only more rapid in its action, less lasting in its effects, and more depressant to the circulation. It may be given in these diseases in single full doses when the temperature exceeds a certain height, say 104° Fahr. 2. In acute rheumatism, salicylate of soda is distinctly **a specific** (much as quinia is a specific against malaria), reducing the temperature, relieving the pain, removing the swelling and other local symptoms, and shortening the duration of the disease. By thus curtailing the course of rheumatism, this drug may indirectly reduce the liability to cardiac and other complications; but it is of no great service directly in this respect. It is of no use in chronic rheumatism or in gout; of doubtful value in rheumatic sciatica. It may be given either in wafers or in solution; and in this country it is now often combined with bicarbonate of potash in free doses (20 gr.). When the pyrexia declines, the dose of the salicylate must be most gradually reduced, as relapses are extremely common after it has been discontinued.

Diphtheria and diabetes have sometimes been successfully treated with salicylates.

Salicin may be used for the same purposes as the salicylates; its action, if less powerful, being better sustained, and the cardiac and vascular depression less marked.

4. REMOTE LOCAL ACTION AND USES.

Salicylic acid is slowly excreted in the urine, sweat, saliva, bile, and mucous secretions generally, mostly as the salicylate or the free acid, partly as salicyluric acid.

Its most important action remotely is on the kidneys and urinary passages, where it is a stimulant and disinfectant, at the same time increasing the acidity. It is thus adapted for the treatment of chronic inflammatory affections of the bladder, with foul alkaline urine and phosphatic deposits. Sometimes, however, it so irritates the kidney as to cause albuminuria and even hæmaturia; and it must be used with great caution, for these or other purposes, if renal disease be present.

LIQUIDAMBARACEÆ.

Styrax Præparatus—PREPARED STORAX.—A balsam obtained from the bark of Liquidambar orientale. Purified by means of rectified spirit and straining.

Characters.—A semi-transparent brownish-yellow semi-fluid resin, of the consistence of thick honey, with a strong agreeable fragrance and aromatic bland taste. Heated in a test tube on the vapour bath, it becomes more liquid but gives off no moisture; boiled with solution of bichromate of potash and sulphuric acid it evolves the odour of hydride of benzoyl.

Composition.—Storax consists of a volatile oil, *styrol*, C_8H_8, *cinnamic acid, cinnamate of cinnamic-æther* (styracin), and various resins. Cinnamic acid, $C_9H_9O_2$, which occurs also in the balsams of Peru and Tolu, is a colourless, odourless, crystalline body, closely allied to benzoic acid, being excreted in the urine partly as hippuric acid.

Dose.—5 to 20 gr.

Storax is contained in:

Tinctura Benzoini Composita.—33 gr. in 1 fl.oz.

ACTION AND USES.

Storax is a **local and remote stimulant, antiseptic, and disinfectant,** like benzoin and the balsams of Peru and Tolu. It is used for scabies and phthiriasis.

ULMACEÆ.

Ulmi Cortex—ELM BARK.—The dried inner bark of Ulmus campestris, Broad-leaved Elm. From trees indigenous to and cultivated in Great Britain.

Characters.—A tough brownish-yellow bark, about half a line thick, without smell; taste mucilaginous, slightly bitter and astringent.

Composition.—Elm bark contains about 3 per cent. of *tannic acid*, 20 per cent. of *mucilage*, and a peculiar brown body, *ulmin*, insoluble in water.

Incompatibles.—Persalts of iron, salts of lead and silver, and gelatine.

Preparation.

Decoctum Ulmi.—1 in 8. *Dose*, 2 to 4 fl.oz.

ACTION AND USES.

Elm bark has a similar action to oak bark and tannic acid, but is **demulcent as well as astringent.**

CUPULIFERÆ.

Quercus Cortex—OAK BARK.—The dried bark of the small branches and young stems of Quercus pedunculata. Collected in spring, from trees growing in Great Britain.

Characters.—Covered with a greyish shining epidermis, cinnamon-coloured on the inner surface, fibrous, brittle, and strongly astringent.

Substance resembling Oak Bark: Pale Cinchona Bark, which is bitter.

Composition.—Oak bark contains 4 to 20 per cent of *tannic* and *gallic acids*, *pectin*, and other constituents of plants.

Incompatibles.—Those of tannic and gallic acids.

Preparation.

Decoctum Quercûs.—1 in 16. *Dose,* 1 in 2 fl.oz. Seldom given internally.

Galla—GALLS.—Excrescences on Quercus infectoria, caused by the punctures and deposited ova of Diplolepis Gallæ tinctoriæ.

Characters.—Hard heavy globular bodies, varying in size from half an inch to three-fourths of an inch in diameter, tuberculated on the surface, the tubercles and intervening spaces smooth; of a bluish-green colour on the surface, yellowish-white within, with a small central cavity; intensely astringent.

Composition.—Galls contain from 15 to 65 per cent. of *tannic acid*, about 5 per cent. of *gallic acid*, and other less important constituents.

Preparations.

1. **Tinctura Gallæ.**—1 in 8. *Dose,* ½ to 2 fl.dr. Seldom used except as a test.
2. **Unguentum Gallæ.**—1 in 6½.

From Unguentum Gallæ is prepared:

Unguentum Gallæ cum Opio.—1 of Opium to 14⅔ of Ointment of Galls.

From Galla are also made:

1. Acidum Tannicum.—Tannic Acid. Tannin. $C_{27}H_{22}O_{17}$. An acid extracted from galls.

Source.—Made by exposing powdered galls to a damp atmosphere; macerating with ether; pressing; and partially evaporating and drying the liquid portion.

Characters.—Pale yellow vesicular masses, or thin glistening scales, with a strong astringent taste, and acid reaction. Solubility: 10 in 8 of water or spirit; sparingly in ether; 1 in 3 of glycerine.

Incompatibles.—Gelatine (which it precipitates, distinguishing it from gallic acid), mineral acids, alkalies;

salts of antimony, lead, silver; persalts of iron, alkaloids, vegetable emulsions.

Dose.—2 to 10 gr.

Preparations.

a. **Glycerinum Acidi Tannici.**—1 to 4. *Dose,* 10 to 40 min.
b. **Suppositoria Acidi Tannici.**—3 gr. in each.
c. **Suppositoria Acidi Tannici cum Sapone.**—3 gr. in each.
d. **Trochisci Acidi Tannici.**—½ gr. in each. *Dose,* 1 to 6.

2. Acidum Gallicum.—Gallic Acid. $H_3C_7H_3O_5.H_2O$. A crystalline acid prepared from galls.

Source.—Made by fermenting a paste of powdered galls and water, boiling with water, straining, and purifying the crystalline product.

Characters.—White or pale fawn silky needles, with an acid taste. Solubility: 1 in 100 of cold water, 1 in 3 of boiling water, 1 in 8 of spirit, 1 in 20 of glycerine. It may be combined with the *proto*-salts of iron. *Resembles* Tannic Acid, but has no astringent taste, and does not precipitate solutions of gelatine.

Incompatibles.—Spiritus Ætheris Nitrosi; metallic salts, including *per*-salts of iron.

Dose.—3 to 10 gr.

Preparation.

Glycerinum Acidi Gallici.—1 to 4. *Dose,* 10 to 60 min.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—The action of tannic acid, and of the many officinal substances which contain it, including oak-bark and galls, depends upon its property of **precipitating albumen and gelatine.** When applied to the skin or exposed mucous surfaces, it condenses or constringes the albuminous and connective tissues, and coagulates the fluids pervading the solid elements (an action which in the dead skin converts the whole into leather). At the same time the sensibility of the nerves is reduced. The vessels are compressed by the constringed tissues to such a degree that their size is indirectly reduced, the circulation through them diminished, and hæmorrhage from them arrested by pressure and by coagulation of the blood by the acid. If a "passive" discharge of plasma and leucocytes is escaping from their walls, as in chronic inflammation, the exudation is stopped. Thus tannic acid is a powerful indirect **styptic and astringent**. Broken surfaces, such as ulcers, have their superficial layers of cells condensed, and the discharge disinfected and coagulated, thus promoting healing. It is a remarkable fact that tannic acid does not actively contract blood-vessels, like lead and silver; on the contrary, it dilates them; but the indirect or constringent influence more than neutralises this.

There is hardly a limit to the application of tannic acid, and preparations containing it, as astringents and styptics. Superficial hæmorrhage from small wounds, the nose, gums, throat, etc., and chronic or subacute inflammatory discharges from the skin, eyes, nose, urethra, vagina, womb, or rectum, may all be treated with it. The acid may be used solid, being dusted or insufflated on the part; in solution as injection, lotion, etc.; or inserted into canals or cavities as bougies or suppositories. The two ointments of galls are favourite applications to hæmorrhoids.

Internally.—In the mouth, tannic acid produces its peculiar "taste," with a sensation of astringency, dryness, roughness, stiffness of the tongue and throat, and thirst; the parts being constringed and partially anæsthetised, and the other effects produced, as described, externally. Preparations containing this drug are in much request in chronic sore throat with a relaxed condition of the uvula, pharynx, and larynx, slight catarrh, cough, and occasional slight bleeding. The trochisci, gargles, sprays, or the glycerine applied with a brush, may be used in different cases.

In the stomach, tannin precipitates the pepsin with the albumens of the gastric juice; and if in quantity, will interfere with digestion by this means, as well as by constringing the mucosa, reducing the circulation, and diminishing the secretion. On the contrary, if a chronic gastric catarrh be present, causing dyspepsia, tannin will give relief by arresting the morbid process, on the principles already discussed. Hæmorrhage from ulcer of the stomach is often successfully treated by free (1 dr.) doses of the acid, which acts as a direct styptic. In the stomach another highly important use is made of the drug, viz. as an antidote to antimony, and such alkaloids as morphia, nicotin, strychnia, etc.; a strong infusion of tea being given if no other tannate is at hand. An emetic or purgative should be afterwards given in alkaloidal poisoning, as the compounds with tannic acid are not perfectly insoluble.

The astringent effect of tannin is continued in the intestines, where it and its compounds are the most popular remedies for diarrhœa, whether alone or combined with other astringents, antacids such as chalk, or anodynes such as opium. Intestinal hæmorrhage may sometimes be arrested by the same means. During its passage along the alimentary canal, part of the tannin is converted into gallic acid, which enters the blood; the rest is excreted in the fæces.

Tannic acid + water = gallic acid + glucose.

$$C_{27}H_{22}O_{17} + 4H_2O = 3H_3C_7H_3O_5 + C_6H_{12}O_6.$$

Gallic acid possesses no local astringent or antiseptic properties, and is therefore seldom if ever given for immediate local purposes.

2. ACTION ON THE BLOOD, AND ITS USES.

Entering the circulation as gallic acid, the preparations of tannin are not certainly known to have any further astringent effect on the vessels, any antiseptic action, or coagulating influence on the blood. If injected directly into the veins, tannic acid would prove rapidly fatal by clotting and embolism.

3. SPECIFIC ACTION AND USES.

The action of these substances on the tissues must depend entirely on the gallic acid. In full doses gallic acid causes circulatory depression, by weakening the heart and dilating the vessels; and it also causes dyspnœa. But besides these effects determined by experiment, it is almost universally regarded to be a specific astringent and **hæmostatic**, and thus to arrest chronic discharges from internal and distant parts, such as the uterus and rectum, and to check bleeding, especially hæmoptysis. Gallic acid is much used for these purposes, and should be given in full doses—even up to one drachm at a time if hæmorrhage be urgent. It must be confessed that some authorities do not believe in this action or use of the drug.

4. REMOTE LOCAL ACTION AND USES.

Tannic and gallic acids are rapidly excreted, chiefly as gallic acid, partly also as pyrogallic acid, in the urine, which is darkened in tint. No remote disinfectant effect is to be obtained in the kidneys or bladder; nor is gallic acid now believed to diminish the albuminuria of Bright's disease. Some hold that it arrests renal hæmorrhage; but in this, and in all kinds of hæmorrhage, there is a constant possible source of error, from the fact that the spontaneous arrest of bleeding is extremely common.

Gallic acid has also been used in night-sweats, with doubtful success.

Acidum Pyrogallicum — PYROGALLIC ACID. Pyrogallol. $C_6H_3(OH)_3$. (*Not Officinal.*)—A body obtained from gallic or tannic acid by carefully heating.

Characters.—Very small shining colourless crystals, becoming black on exposure; odourless, insipid; not acid to test-paper; readily soluble in water.

Dose.—½ to 1½ gr.

ACTION AND USES.

Pyrogallic acid has a powerful affinity for oxygen, and is thus **antiseptic and disinfectant** (in 1 to 2½ per cent. solutions). It stains the skin and hair dark without injuring their structure. It also acts as a powerful but somewhat painful local stimulant, which will destroy excessive cutaneous growths, and may be used (60 gr. to one ounce of lard) in psoriasis, but only when the patches of disease are small, in lupus, and in epithelial cancer.

Whether applied freely to the skin, or given internally in large doses, pyrogallic acid has a destructive influence on the blood, which assumes a brown "fluid" appearance and readily coagulates, the corpuscles being the elements affected. Vomiting, purging, bloody urine, great nervous and general depression, are the results of this blood change, which may prove fatal; hence the caution given in the last paragraph. The drug has been used in hæmoptysis.

MORACEÆ.

Ficus—FIG.—The dried fruit of Ficus Carica. Imported from Smyrna.

Composition.—Figs contain chiefly *sugar* and *mucilaginous* substances.

Figs are contained in Confectio Sennæ.

ACTION AND USES.

The dried fig is a very pleasant **demulcent and nutritive** substance with **laxative** properties, and may be ordered as an article of diet in habitual constipation. It is sometimes used locally as a poultice to gum-boils.

Mori Succus—MULBERRY JUICE.—The Juice of the ripe fruit of Morus nigra.

Characters.—Of a dark violet colour, with a faint odour, and an acidulous sweet taste.

Preparation.

Syrupus Mori.—*Dose,* 1 to 2 fl.dr.

ACTION AND USE.

Mulberry juice is a pleasant **flavouring and colouring agent.**

CANNABINACEÆ.

Cannabis Indica—INDIAN HEMP.—The dried flowering tops of the female plants of Cannabis sativa. For medicinal use that which is grown in India, and from which the resin has not been removed, is alone to be employed.

Characters.—Tops consisting of one or more alternate branches, bearing the remains of the flowers and smaller leaves and a few ripe fruits, pressed together in masses which are about two inches long, harsh, of a dusky-green colour and a characteristic odour. Various preparations are known in different parts of the East, as Bang, Hashish, Churrus, and Gunjah.

Composition.—Cannabis indica contains a brown amorphous resin, *cannabin,* and a volatile oil, *cannaben,* either or both of which may be the active principle.

Preparations.

1. **Extractum Cannabis Indicæ.**—Alcoholic. 6 in 1. *Dose,* $\frac{1}{4}$ to 1 gr.
2. **Tinctura Cannabis Indicæ.**—1 in 20. *Incompatibles,* water and watery infusions. *Dose,* 5 to 20 min. rubbed with 1 fl.dr. of mucilage.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION, AND ACTION ON THE BLOOD.

Positive knowledge on these points is wanting; but the drug certainly does not derange the stomach and intestines like opium. It is never used externally. Internally the extract forms a useful **corrective** of some griping purgatives, such as podophyllin or colocynth.

2. SPECIFIC ACTION AND USES.

The action of cannabis indica is ill understood. It chiefly affects the convolutions, **producing a species of intoxication**; disordered consciousness of personality, locality, and time; and exaltation of the feelings, with pleasing grandiose ideas and hallucinations. Noisy, restless delirium, with muscular excitement, or, more commonly, sleep supervenes; and therewith any pain that may be present is relieved. The heart and blood pressure appear to be first stimulated and afterwards depressed.

Cannabis indica was formerly used as a **hypnotic and anodyne**, when opium disagreed or had been taken in excess; but, from its uncertainty, it has been generally replaced by chloral. Combined with bromide of potassium, it is useful in mania. More frequently it is given as a special anodyne and antispasmodic in dysmenorrhœa, menorrhagia and hysteria. It may also be tried in neuralgia, and in spasmodic asthma (as cigarettes), when other remedies fail.

3. REMOTE LOCAL ACTION.

Nothing is definitely known respecting the excretion of cannabis indica. It increases the amount of urine, probably through the blood pressure.

Lupulus—HOP.—The dried strobiles of the female plant of Humulus lupulus. Cultivated in England.

Characters.—Strobiles of a greenish-yellow colour, with minute yellow grains (lupuline) adherent to the base of the scales. Odour, aromatic; taste, bitter.

Composition.—Hops contain an *aromatic volatile oil, valerol*, $C_6H_{10}O$, on which its smell depends; 11 per cent. of a crystalline bitter principle, *lupulinic acid*, $C_{32}H_{50}O_7$; and *tannin.*

Incompatibles.—Mineral acids and metallic salts.

Preparations.

1. **Extractum Lupuli.** Alcoholic and aqueous.—4 in 1. *Dose,* 5 to 15 gr.
2. **Infusum Lupuli.**—1 in 20. *Dose,* 1 to 2 fl.oz.
3. **Tinctura Lupuli.**—1 in 8. *Dose,* ½ to 2 fl.dr.

ACTION AND USES.

The action and uses of hops depend upon the presence of its two important constituents, which exert the characteristic effects of the class to which they respectively belong. The primary stimulant, and secondary sedative and soporific effects of the **aromatic** oil associated with those of alcohol, are seen in ales and beers, less distinctly in the officinal preparations. The **stomachic and tonic** effect of the **bitter** lupulinic acid is equally familiar in wholesome bitter ale. Ale is moderately laxative and **diuretic** by virtue of the essential oil.

Hops are used medicinally chiefly in the form of pure bitter ales, to produce the effects just indicated, especially to rouse and improve the appetite in convalescence and other low states of the system, and to **promote sleep.** The officinal preparations sometimes relieve the craving of alcoholism, and act as anaphrodisiacs.

CONIFERÆ.

Terebinthinæ Oleum—OIL OF TURPENTINE. —The oil distilled from the oleo-resin (turpentine), obtained from Pinus palustris, Pinus Tæda, and sometimes Pinus Pinaster.

Characters.—Limpid, colourless, with a strong peculiar odour, and a pungent and bitter taste. Sp. gr., 0·864. Mixes with other volatile and fixed oils, and dissolves resins, wax, sulphur, phosphorus, and iodine. Solubility, 1 in 10 of rectified spirit; remains transparent with chloroform.

Composition.—The oleo-resin, common turpentine, as it flows from trees, is an impure solution of *resin* in the officinal *volatile oil.* The oil of turpentine, $C_{10}H_{16}$, with the characters just described, readily absorbs oxygen, and is converted into the resin, which thus increases with the exposure of the oleo-resin to air. When the latter is distilled, the volatile oil passes over, leaving the resin behind. Oil of turpentine is isomeric with a number of volatile oils already met with in the materia medica.

Dose.—10 to 30 min.; as an anthelmintic, 2 to 4 fl.dr.

Preparations.

1. **Confectio Terebinthinæ.**—1, with Liquorice 1, and Honey 2. *Dose,* 60 to 120 gr.
2. **Enema Terebinthinæ.**—1 oz., with Mucilage of Starch 15 oz.; for one enema.

3. **Linimentum Terebinthinæ.**—16, with Camphor 1, and Soft Soap 2.
4. **Linimentum Terebinthinæ Aceticum.**—1, with Acetic Acid 1, and Liniment of Camphor 1.
5. **Unguentum Terebinthinæ.**—1 in $2\frac{1}{8}$.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Applied to the skin or exposed mucous surfaces, turpentine is **antiseptic and disinfectant**, and produces a sense of heat and redness, followed by burning and vesication, the local circulation being stimulated, and the local nerves first irritated and then depressed. Turpentine is therefore in very extensive use as a **local stimulant and counter-irritant:** (*a*) In painful affections of a local kind, such as chronic rheumatism of muscles or joints, and neuralgia, in the form of the liniments, the resin plaster, and turpentine stupes. (*b*) In affections of deep parts, to act reflexly on the vessels and nerves; for instance, to relieve bronchitis by being rubbed on the chest, meteorism by application to the abdomen as stupes, or affections of joints by inunction over them. (*c*) As a disinfectant and stimulant it may be applied to ulcers and wounds, the Unguentum Resinæ being very useful for this purpose, whilst the pure oil may be applied to hospital gangrene. Turpentine is absorbed by the unbroken skin, and its action in meteorism may be partly accounted for in this way, as we shall see.

Internally.—Oil of turpentine with its characteristic taste, produces reflex salivation, and possibly in this way improves the digestion when given in small doses. Having reached the stomach it is, as externally, disinfectant, stimulant to the vessels, sedative to the local nerves, and reflexly stimulant, at least for a time. In a word, turpentine is a powerful *carminative.* It is but little given for this purpose, because unpleasant to the taste and often disagreeable in its own effects, and because we have abundance of other aromatic volatile oils, equally powerful, and without either of these drawbacks. See *Caryophyllum*, page 242.

Turpentine passes into the bowel, and may be found even in the colon (which may, however, *excrete* it also, as will be described). Here it acts reflexly as a **stimulant to the muscular coat**, causing contraction, expulsion of gas and fæces, and recovery of tone if it have been lost by tympanitic distension; and is also a disinfectant and vascular stimulant. In larger doses these effects proceed to purgation. It is therefore given in tympanites, either by the mouth or as the enema, especially when this is associated with constipation; and it has proved useful in some forms of diarrhœa and dysentery. It may also be advantageously added to enemata after hæmorrhage from any part, being, as we shall see, hæmostatic.

Turpentine proves to be an **anthelmintic**, and is given either by the mouth for the tape-worm, in doses of ½ to 2 fl.dr., which may certainly cause unpleasant symptoms; or as the Enema, for the thread-worm, an excellent method.

Another local application of oil of turpentine is to the respiratory organs, as an inhalation. The diluted vapour in steam should be used, or the pure vapour inhaled from a warm sponge, which may however be irritant. Turpentine enters the blood thus, but the chief action desired is a purely local one, to disinfect and stimulate the chronically inflamed or ulcerated surfaces of the lungs and bronchi, and correct the smell and irritant properties of the products. It is therefore used in gangrene of the lung, dilated bronchi, and other allied conditions.

2. ACTION ON THE BLOOD.

Oil of turpentine is freely absorbed by all surfaces, and enters the blood unchanged. Thus introduced, it produces none of the rapidly fatal effects which follow its injection into the veins of animals, and which are referable in part to coagulation and its results. Probably, however, even in medicinal quantities, turpentine is partially oxydised at the expense of the blood.

3. SPECIFIC ACTION AND USES.

Found unchanged in the tissues and organs, oil of turpentine sets up a series of symptoms, mainly depressant in their character, which follow the reflex stimulant effects already described as referable to its action on the nerves and vessels of the stomach. A full dose produces a feeling of languor, debility, nausea, dulness, sleepiness, and unsteady gait; a large dose may lead to coma. These **sedative effects on the nervous system** may account for the success of the empirical use of turpentine in painful affections such as neuralgia, especially obstinate sciatica.

At the same time the heart is disturbed by the oil, and the blood pressure decidedly falls. Here we may find the explanation, in part, of the unquestionable value of turpentine as a **hæmostatic**. Of all the means of arresting internal hæmorrhage, it frequently proves itself to be the most powerful: bleeding from the lungs, stomach, bowels, and uterus will often cease after a full dose of turpentine, when every other drug has failed. It appears to be specially useful in intestinal hæmorrhage from typhoid ulceration. In all such cases the oil must be fearlessly exhibited, since life is at stake, a dose of ½ fl.dr. being followed every two hours by doses of 15 to 20 min.

The temperature is believed to be lowered by turpentine.

This substance is also a physiological **antidote to phosphorus**, and may be used (best in the form of the crude oil) either to prevent chronic phosphorus poisoning in workmen, or in small repeated doses in acute poisoning, after sulphate of copper. See *Phosphorus* (page 99) and *Copper* (page 65).

4. REMOTE LOCAL ACTION AND USES.

Oil of turpentine, like the volatile oils, is excreted, mainly as such, by the cutaneous and mammary glands, by the lungs and respiratory passages, by the kidneys, and possibly by the liver, biliary mucosa, and intestines. All these organs are influenced by the oil as it passes through them. Perspiration is slightly increased, and an eruption may appear on the skin. In the bronchial walls it acts as a vascular stimulant, and disinfects both these and their products; it might therefore be a valuable drug in chronic bronchitis, dilated bronchi, and gangrene of the lungs. Its effect as it passes through the kidneys accounts for the comparatively little use that is made of it in these and other diseases. Even in moderate doses it may produce symptoms of **irritation and congestion of the renal organs,** including lumbar pain, repeated painful ineffectual attempts at micturition, a sense of heat and spasm in the perineum, frequently with hæmaturia. Whilst small doses cause diuresis, large doses may cause complete suppression. It may be occasionally used with caution in Bright's disease, and even in hæmaturia. Part of the turpentine is excreted as a fragrant violet-smelling body, and this and the unchanged portion exert a remote local effect as stimulants and disinfectants in the bladder and urethra, so that cystitis and gleet have been treated with the oil.

In passing through the biliary passages, turpentine is believed to prevent or dissolve gall stones. Its excretion by the colon probably contributes to its effect in emptying the bowel of gas and fæces.

Resina—Resin.—The residue of the distillation of the turpentines from various species of Pinus and Abies.

Characters.—Translucent, yellowish, brittle, pulverisable; fracture shining; odour and taste faintly terebinthinate. It is easily fusible, and burns with a dense yellow flame and much smoke. It is soluble in its own weight of oil of turpentine.

Composition.—Resin consists of three resinous acids, *abietic*, *sylvic*, and *pimaric*, $C_{20}H_{30}O_2$; neutral resins; and a trace of *oil of turpentine.*

Preparations.

1. **Emplastrum Resinæ.**—1 in 9½.
2. **Unguentum Resinæ.**—"Basilicon." 1 in 3½.

Resin is contained in many other plasters and ointments, and in Charta Epispastica.

ACTION AND USES.

Resin is a mild **local stimulant,** either of the unbroken skin or of sores and wounds, and the Unguentum is used for this purpose. Resin is also an ingredient of many plasters, to which it gives consistence and adhesiveness.

Terebinthina Canadensis—CANADA BALSAM.—The turpentine obtained by incision from the stem of Abies balsamea, Balm of Gilead Fir. From Canada.

Characters.—A pale yellow ductile oleo-resin, of the consistence of thin honey, with a peculiar agreeable odour, and a slightly bitter feebly acrid taste; by exposure drying very slowly into a transparent adhesive varnish; solidifying when mixed with a sixth of its weight of magnesia.

Composition.—Canada "balsam" contains 17 per cent. of a *volatile oil.* The *resin* is dissolved in this.

Dose.—20 to 30 gr.

Canada Balsam is contained in Charta Epispastica and Collodium Flexile.

ACTION AND USES.

Canada balsam is chiefly **used for its physical properties.** It has been given internally to produce the effects of oil of turpentine in a milder form.

Laricis Cortex—LARCH BARK.—The bark, deprived of its outer layer, of Larix europæa, *D.C.*, Abies Larix *Rich.*, the common Larch.

Characters.—In flat pieces; the inner surface yellow and fibrous, outer reddish-brown under a greyish epidermis. Has a faint odour of turpentine.

Substance resembling Larch Bark: Red Cinchona Bark, known by bitter taste.

Composition.—Larch bark yields an oleo-resin, *Venetian turpentine*, brownish-yellow, tenacious, with an aromatic bitter taste and a pleasant nutmeg-like odour. In its general characters and properties it closely resembles ordinary crude turpentine.

Preparation.

Tinctura Laricis.—1 in 8. *Dose*, 20 to 30 min.

ACTION AND USES.

Larch closely **resembles turpentine in its action**, but is more pleasant. It is used (but rarely) in the same class of cases.

Thus Americanum—COMMON FRANKINCENSE. The concrete turpentine of Pinus Tæda, the Frankincense Pine, and Pinus palustris, the Swamp Pine. From the southern states of North America.

Characters.—A softish, bright-yellow, opaque solid, resinous but tough, having the odour of American turpentine.

Composition.—This is apparently the same as the composition of common resin.

Thus Americanum is contained in Emplastrum Picis.

ACTION AND USES.

Frankincense has **the same action and uses as resin** and its allies just described.

Pix Burgundica — BURGUNDY PITCH. — A resinous exudation from the stem of the Spruce Fir, Abies excelsa. Melted and strained; imported from Germany.

Characters.—Hard and brittle, yet gradually taking the form of the vessel in which it is kept; opaque, varying in colour, but generally dull reddish-brown; of a peculiar somewhat empyreumatic perfumed odour, and aromatic taste, without bitterness; free from vesicles; gives off no water when heated.

Composition.—Burgundy pitch consists of various *resinous acids,* as in ordinary resin, combined with *oil of turpentine.* A special *volatile oil* imparts to it its odour.

Preparation.

Emplastrum Picis.—1 in 2.

Pix Burgundica is also contained in Emplastrum Ferri.

ACTION AND USES.

Burgundy pitch has a **mildly stimulant** action on the skin, and is used only for making plasters.

Pix Liquida—TAR.—A bituminous liquid obtained from the wood of Pinus sylvestris and other pines by destructive distillation.

Characters.—Thick, viscid, brownish-black, of a well-known peculiar aromatic odour. Water agitated with it acquires a pale-brown colour, sharp empyreumatic taste, and acid reaction.

Composition.—Tar is a variable mixture of *creasote*, *phenol* (carbolic acid), *toluol, xylol, acetic acid, turpentine, resin,* etc.

Dose.—20 to 60 min. in pill.

Preparation.

Unguentum Picis Liquidæ.—5 in 7.

ACTION AND USES.

Tar, being a compound of creasote, carbolic acid, and other substances, possesses an action very similar to the first two of these bodies, to which the student is referred. Its exact composition being variable, the action of tar is uncertain; and internally it is now but little employed.

Externally, it is more valuable than either of its important constituents, as a **vascular stimulant and alterative** in dry skin diseases, such as chronic eczema and psoriasis; and as a nervous sedative in prurigo and other kinds of itching.

Internally, tar may be given in pills, in capsules, or as tar-water, made by shaking up a pint of tar with half-a-gallon of water, and decanting after settlement—a very popular panacea a hundred years ago. Tar may still be used as a disinfectant in the stomach and bowels (see *Creasotum*, page 172), and as a **remote disinfectant and deodorant** in foul discharges from the bronchi and lungs, through which it is probably in part excreted.

Juniperi Oleum—OIL OF JUNIPER.—The oil distilled in Britain from the unripe fruit of Juniperus communis.

Characters of the fruit.—The size of a large pea, of a blackish-purple colour, covered by a glaucous bloom; marked with a tri-radiate groove. Taste sweetish, terebinthinate; odour agreeable and balsamic.

Characters of the oil.—Colourless, or pale greenish-yellow, of a sweetish odour and warm aromatic taste.

Composition.—Juniper berries contain the officinal *volatile oil*, a quantity of *grape sugar*, *resin*, and colouring matter. The oil is a complex compound of terpenes and camphors.

Dose.—1 to 3 min.

Preparation.

Spiritus Juniperi.—1 in 50. *Dose*, 30 to 60 min.

Spiritus Juniperi is contained in Mistura Creasoti.

ACTION AND USES.

The physiological action of juniper naturally resembles closely that of turpentine, but its remote local stimulant action on the kidney is peculiarly marked, whilst this drug is neither disagreeable nor dangerously powerful like the other. Thus it acts as a **stomachic, stimulant, and anti-spasmodic**; is absorbed into the blood; is excreted in the urine, to which it imparts a violet odour; acts as a **direct diuretic**, increasing both solids and water; and in large doses causes strangury and renal inflammation.

Juniper is used almost entirely as a diuretic in dropsy not dependent on acute renal disease, *i.e.* in cardiac and hepatic dropsy, and in some cases of chronic Bright's disease. It is best given combined with saline diuretics, or in the form of "Hollands."

Sabinæ Cacumina—SAVIN TOPS.—The fresh and dried tops of Juniperus Sabina. Collected in spring, from plants cultivated in Britain.

Characters.—Twigs, densely covered with minute imbricated appressed leaves in four rows; odour strong, peculiar, and unpleasant; taste acrid, bitter, resinous, and disagreeable.

Composition.—Savin contains the officinal *volatile oil*, isomeric with turpentine, $C_{10}H_{16}$, colourless or pale yellow, limpid, with an unpleasant odour and bitter acrid taste.

Preparations.

Dose, in powder.—4 to 10 gr.

1. **Oleum Sabinæ.**—Distilled in Britain from *fresh* savin. *Dose*, 1 to 5 min.
2. **Tinctura Sabinæ.**—1 of *dried* tops in 8. *Dose*, 15 to 30 min.
3. **Unguentum Sabinæ.**—1 of *fresh* tops in $3\frac{3}{8}$.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—The action of savin closely resembles that of oil of turpentine, but it is more **irritant, causing vesication** of the unbroken skin, and a profuse flow of pus from a wounded surface. It was formerly used to promote the discharge from blisters or issues, a practice now seldom resorted to. It rapidly dispels small venereal warts or condylomata.

Internally.—Savin is a powerful gastro-intestinal irritant, to be avoided, or only used with great caution.

2. ACTION IN THE BLOOD; SPECIFIC AND REMOTE LOCAL ACTION AND USES.

Oil of savin is absorbed, carried through the organs, and excreted like oil of turpentine. It thus acts as a remote local **irritant to the kidneys** and mucous membranes, especially those of the genital part, causing hyperæmia of the ovaries and uterus, increased menstrual activity, and contraction of the pregnant uterus. It has been used as an **emmenagogue**, but requires the exercise of great care. More frequently it is given as an ecbolic for criminal purposes, and then often proves fatal as a gastro-intestinal irritant.

ZINGIBERACEÆ.

Zingiber—GINGER.—The scraped and dried rhizome of Zingiber officinale. From plants cultivated in the West Indies, India, and other countries.

Characters.—Irregular lobed decorticated pieces, three or four inches long, subcompressed, yellowish-white but not chalky on the surface, with a short mealy fracture, hot taste, and agreeable aroma. Powder yellowish-white.

Substance resembling Ginger: Turmeric, known by colour.

Composition.—Ginger contains an *aromatic volatile oil*, the exact composition of which is uncertain.

Dose.—10 to 20 gr.

Preparations.

1. **Tinctura Zingiberis.**—1 in 8. *Dose*, 10 to 30 min.
2. **Tinctura Zingiberis Fortior.**—"Essence of Ginger." 1 in 2. *Dose*, 5 to 20 min.

From this is prepared:

Syrupus Zingiberis.—1 of Strong Tincture in 26. *Dose*, 1 to 4 fl.dr.

Ginger is also contained in a variety of powders, and other preparations of more important drugs.

ACTION AND USES.

Ginger acts and is used like other substances containing aromatic volatile oils. It is one of the most generally employed of all **carminatives.**

Curcuma—TURMERIC.—The rhizome of Curcuma longa.

Composition.—Turmeric contains a yellow crystalline *colouring matter*, a *volatile oil*, *resin*, and *starch.*

Preparations.

1. **Turmeric Tincture.**—1 in 6.
2. **Turmeric Paper.**

USE.

Turmeric paper is **used pharmaceutically as a test** for alkalies, which change the yellow to a reddish-brown. As a condiment it is a constituent of curry powder.

Cardamomum—CARDAMOMS.—The dried capsules of the Malabar Cardamom, Elettaria Cardamomum. Cultivated in Malabar. The seeds are best kept in their pericarps, from which they should be separated when required for use, the pericarpial coats being rejected.

Characters.—Seeds obtusely angular, corrugated, reddish-brown, internally white, with a warm aromatic agreeable taste and odour, contained in ovate-oblong triangular pale-brown coriaceous ribbed pericarps.

Composition.—The active principle of cardamoms is an *aromatic oil*, $C_{10}H_{16}$, isomeric with turpentine.

Preparation.

Tinctura Cardamomi Composita.—1 in 80, coloured with Cochineal. *Dose*, ½ to 2 fl.dr.

Tinctura Cardamomi Composita is contained in Decoctum Aloes Compositum; Mistura Ferri Aromatica; Mistura Sennæ Composita; and Tinctura Chloroformi Composita.

Cardamoms are also contained in many preparations as a flavouring agent.

ACTION AND USES.

Cardamoms serve as a highly agreeable, slightly stimulant, **flavouring and carminative agent** allied to the peppers.

IRIDACEÆ.

Crocus—SAFFRON.—The dried stigma, and part of the style, of Crocus sativus. Imported from Spain, France, and Italy.

Characters.—Thread-like styles, each terminated by three long orange-brown stigmas, broadest at the summit. Has a powerful aromatic odour. Rubbed on the wet finger it leaves an intense orange-yellow tint. When pressed between folds of white filtering paper it leaves no oily stain.

Composition.—Saffron contains *saffranin* or *polychroite*, an orange-red glucoside, which yields a red colouring matter, *crocin*; and a *volatile oil* allied to turpentine.

Impurities.—Marigold and sunflower petals.

Preparation.

Tinctura Croci.—1 in 20. *Dose*, ½ to 2 fl.dr.

Saffron is also extensively used as a colouring agent.

ACTION AND USES.

Crocus is used only to **colour officinal preparations.**

Iris—BLUE FLAG. (*Not Officinal.*)—The rhizome and rootlets of Iris versicolor.

Characters.—Rhizome 2 to 4 inches long, jointed, terminated by a scar, annulated from the leaf-sheaths, grey-brown. Rootlets long and simple; odour slight; taste acrid and nauseous.

Composition.—A resinoid substance, *iridin*, has been obtained from the root, the exact composition of which appears to be undetermined.

Non-officinal Preparations.

Extractum Iridis (U. S. P.).—*Dose*, 1 to 5 gr.

Extractum Iridis Fluidum (U. S. P.).—*Dose*, 5 to 60 min.

Iridin.—A powdered extractive; dark-brown; bitter, nauseous, and acrid to the taste. *Dose*, 1 to 5 gr.

ACTION AND USES.

Iridin is a powerful **hepatic stimulant or direct cholagogue, and cathartic**; possibly also diuretic. It is a useful purgative in disorder of the liver and duodenum, whether given alone or combined with other remedies.

SMILACEÆ.

Sarsæ Radix—JAMAICA SARSAPARILLA.—The dried root of Smilax officinalis. Native of Central America; imported from Jamaica.

Characters.—Roots not thicker than a goose-quill, generally many feet in length, reddish-brown, covered with rootlets, and folded in bundles about eighteen inches long; scentless; taste mucilaginous, feebly bitter, faintly acrid.

Substances resembling Sarsa: Senega, which is twisted; Hemidesmus, cracked transversely.

Composition.—Sarsaparilla contains a small quantity of *volatile oil*, a colourless crystalline neutral principle, *smilacin*, $C_{18}H_{30}O_6$, *resin*, *starch*, *mucilage*, etc.

Impurities.—Inferior kinds, and Dulcamara.

Preparations.

1. **Decoctum Sarsæ.**—1 in 8. *Dose*, 2 to 10 fl.oz.
2. **Decoctum Sarsæ Compositum.**—Sarsaparilla, 2½ oz.; Sassafras, ¼ oz.; Guaiacum Wood, ¼ oz.; Liquorice, ¼ oz.; Mezereon, 60 gr.; Water, 30 oz. *Dose*, 2 to 10 fl.oz.
3. **Extractum Sarsæ Liquidum.**—2 in 1. *Dose*, 1 to 4 fl.dr.

ACTION AND USES.

The physiological action of sarsaparilla is unknown, the diaphoretic and diuretic effects which follow large draughts of its fluid preparations being generally referred to the water alone. It is tolerated in very large doses by the stomach. Smilacin is excreted in the urine.

Great diversity of opinion exists as to the value of sarsaparilla therapeutically. Whilst the pharmacological evidence is negative, as we have seen, the clinical evidence is entirely discordant, some authorities considering it an **alterative** drug of extraordinary value in syphilis, chronic skin-disease, and rheumatism, others entirely worthless. On the one hand, many cases of these diseases are greatly benefited by careful treatment, with rest, good food, baths, and abundance of warm fluids alone; and, on the other hand, sarsaparilla is almost always combined with other drugs, including guaiacum, sassafras, mezereon, iodide of potassium, and mercury. If given, it is indicated in old standing cases of syphilis in feeble subjects, who have already suffered from the abuse of mercury or iodine, and the compound decoction should be freely used.

LILIACEÆ.

Scilla—Squill.—The sliced and dried bulb of Urginea Scilla. From the Mediterranean coasts.

Characters.—Bulb pear-shaped, weighing from half a pound to ten pounds; outer scales membranous, brownish-red or white; inner scales thick, whitish, fleshy, juicy; taste mucilaginous, intensely and disagreeably bitter, somewhat acrid. The dried slices are white or yellowish-white, slightly translucent, scentless, disagreeably bitter; brittle, and easily pulverisable if very dry, but if exposed readily recovering moisture and flexibility.

Substance resembling Scilla: Tragacanth, which is more horny.

Composition.—Squill contains, besides the usual constituents of plants, an active bitter glucoside *scillaïn.* Another substance called *scillitin* is really but an extract of variable strength and properties.

Dose, in powder.—1 to 3 gr.

Preparations.

1. **Acetum Scillæ.**—1 in 8. *Dose,* 15 to 40 min.

From Acetum Scillæ are prepared:

a. Oxymel Scillæ.—5 of the Acetum with 8 of Honey. *Dose*, ½ to 1 fl.dr.

b. Syrupus Scillæ.—1 of the Acetum with 2 of Sugar. *Dose*, ½ to 1 fl.dr.

2. **Pilula Scillæ Composita.**—Squill, 1¼; Ginger, 1; Ammoniacum, 1; Hard Soap, 1; Treacle, 2. *Dose*, 5 to 10 gr.
3. **Pilula Ipecacuanhæ cum Scillâ.**—1 in 7. *Dose*, 5 to 10 gr.
4. **Tinctura Scillæ.**—1 in 8. *Dose*, 15 to 30 min.

ACTION AND USES.

The action of this important drug so **closely resembles that of digitalis**, that it is unnecessary to give it in detail. The student is therefore referred to all that is said respecting digitalis (page 310), and will apply it to squill. Briefly, it produces the same increase of vigour and diminution of frequency of the cardiac action; the same contraction of the peripheral vessels and rise of pressure, followed by relaxation commencing in the renal arterioles; and therefore the same kind of diuresis.

Squill is employed in the same class of cases as digitalis, most frequently in combination with this drug, diuretics being most active when given together. It must not however be given continuously, but with occasional intermissions, when it is more actively diuretic and less irritant to the stomach and kidney.

Two properties, however, distinguish squill from digitalis, and have to be carefully observed:

1. Squill is much **more irritant to the stomach and intestines than digitalis**, causing vomiting and purging in full doses, and very liable to produce dyspepsia even in medicinal quantities. It is thus a drug which must often be withheld when most clearly indicated, one of the first principles of therapeutics being never to derange the stomach.

2. Squill is a **powerful expectorant.** This action is probably a remote local one, the scillaïn stimulating the bronchial wall during excretion, as it irritates the gastro-intestinal wall during absorption, in this respect resembling ipecacuanha (emetin) and senegin. It is much employed as a stimulant expectorant in bronchitis, when the indication is to increase the local circulation and secretion, and accelerate the removal of the products. It is therefore suitable for chronic cases, especially if the right ventricle be secondarily affected, as it strengthens the heart and promotes diuresis. It is contra-indicated in acute bronchitis, in interesting contrast to ipecacuanha

(see *Ipecacuanha*, page 267); and must also be withheld when the stomach is feeble or deranged, as in phthisis. The routine use of squill for all kinds of cough is to be deprecated.

Convallaria.—The entire plant of Convallaria majalis, the Lily of the Valley. (*Not Officinal.*)

Characters.—Leaves radical, usually two, oblong, tapering at both ends, 4 to 6 inches long. Flower stem leafless, radical, shorter than the leaves. Flowers drooping, bell-shaped, in a loose raceme.

Composition.—Lily of the valley contains two glucosides, *convallarin*, crystalline, insoluble in water; and *convallamarin*, white, amorphous, bitter, and soluble in water and in spirit.

Non-officinal Preparations.

Extract of Convallaria.—Aqueous. *Dose*, 2 to 8 gr.
Convallamarin.—*Dose*, ½ to 2 gr.
An Infusion may also be used.

ACTION AND USES.

Convallaria has an action very similar to that of squill and digitalis, the active principles of which are also glucosides. In medicinal doses it **slows and strengthens the heart, raises the blood pressure, and is a decided diuretic.** It has proved remarkably useful in some cases of cardiac dropsy. At the same time it is a gastro-intestinal irritant like squill, this effect being due to the convallarin, whilst the convallamarin acts on the circulation. Aqueous preparations, or the pure convallamarin, should therefore be given.

Aloe Barbadensis—BARBADOES ALOES.—The inspissated juice of the leaf of Aloe vulgaris. Imported from Barbadoes.

Characters.—In yellowish-brown or dark-brown opaque masses; breaks with a dull conchoidal fracture; has a bitter nauseous taste, and a strong disagreeable odour; dissolves almost entirely in proof spirit, and during solution exhibits microscopically numerous crystals. Usually imported in gourds.

Substances resembling Aloes: Guaiacum, Scammony, and Catechu, all destitute of bitter taste.

Aloe Socotrina—Socotrine Aloes.—The inspissated juice of the leaf of one or more undetermined species of Aloe. Produced chiefly in Socotra, and shipped to Europe by way of Bombay.

Characters.—In reddish-brown masses, opaque, or translucent at the edges; breaks with an irregular or smooth and resinous fracture; has a bitter nauseous taste, and a strong but fragrant odour; dissolves entirely in proof spirit, and during solution exhibits microscopically numerous minute crystals.

Composition.—Aloes contains: (1) *Aloin*, $C_{17}H_{18}O_7$, an inodorous body, with a taste at first sweet, afterwards intensely bitter; partly crystallising in small colourless needles, partly amorphous and then called *aloëtin;* readily soluble in hot water, the heat converting the crystalline into the amorphous form. (2) *Aloe resin*, a brown translucent body, insoluble in water. (3) *Gallic acid*, in small quantity. (4) A *volatile oil*, the source of the odour of aloes. (5) Various less important bodies.

Dose.—Of either kind of aloes, 2 to 6 gr.

Preparations.

A. *Of Aloe Barbadensis:*

1. **Enema Aloes.**—40 gr.; Carbonate of Potash, 15 gr.; Mucilage of Starch, 10 fl.oz. For one enema.
2. **Extractum Aloes Barbadensis.**—Aqueous. 1¼ in 1. *Dose*, ½ to 2 gr.
3. **Pilula Aloes Barbadensis.**—Aloes, 2; Hard Soap, 1; Oil of Caraway, ⅛; Confection of Roses, 1. *Dose*, 4 to 8 gr.
4. **Pilula Aloes et Ferri.**—Aloes, 2; Sulphate of Iron, 1½; Compound Powder of Cinnamon, 3; Confection of Roses, 4. *Dose*, 5 to 10 gr.

Barbadoes Aloes is also an important ingredient of Pilula Cambogiæ Composita, Pilula Colocynthidis Composita, and Pilula Colocynthidis et Hyoscyami.

B. *Of Aloe Socotrina:*

1. **Enema Aloes.**—Prepared as from Barbadoes Aloes.
2. **Extractum Aloes Socotrinæ.**—Aqueous. 2 in 1. *Dose*, 1½ to 3 gr.

From Extractum Aloes Socotrinæ is prepared:

Decoctum Aloes Compositum.—Extract, 120 gr.; Myrrh, 90 gr.; Saffron, 90 gr.; Carbonate of Potash, 60 gr.; Extract of Liquorice, 1 oz.; Compound Tincture of Cardamoms, 8 fl.oz.; and Water to make 30 oz. 4 gr. in 1 fl.oz. *Dose*, ½ to 2 fl.oz.

Extractum Aloes Socotrinæ is also an ingredient of Extractum Colocynthidis Compositum. 1 in 2¼ nearly.

3. **Pilula Aloes Socotrinæ.**—1 in 2. *Dose*, 5 to 10 gr.
4. **Pilula Aloes et Assafœtidæ.**—Equal parts of Aloes, Assafœtida, Hard Soap, and Confection of Roses. 1 in 4. *Dose*, 5 to 10 gr.
5. **Pilula Aloes et Myrrhæ.**—Aloes, 2; Myrrh, 1; Saffron, ½; Confection of Roses, 2½. 1 in 3. *Dose*, 5 to 10 gr.
6. **Tinctura Aloes.**—1 in 40. *Dose*, 1 to 2 fl.dr.
7. **Vinum Aloes.**—Nearly 2 gr. in 1 fl.dr. *Dose*, 1 to 2 fl.dr.

Aloes Socotrina is also an important ingredient of Pilula Rhei Composita, 1 in 6; and Tinctura Benzoini Composita, 8 gr. to 1 fl.oz.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Aloes acts upon the stomach and intestines as a **bitter and purgative.** The former effect is fully described under *Calumbæ Radix*, page 181. As a purgative, aloes is peculiar in **acting chiefly upon the colon.** Ten to fifteen hours or even more after an ordinary dose, rarely sooner, a soft formed or lightly relaxed motion is passed. Very large doses may not act more quickly, but much more violently, with pain, straining, and possibly bleeding from the rectum. Aloes is thus the slowest of all purgatives. The presence of bile is believed to be required to insure the action of the purgative aloin, and the drug is, in turn, a stimulant of the biliary flow. The pelvic circulation generally, as well as that of the rectum, is excited by aloes, which may cause hæmorrhoids and hæmorrhage from the bowel, **increased uterine activity,** menstruation, possibly menorrhagia, and even abortion if given in large doses, in certain subjects, or repeatedly.

Aloes is used as one of our most valuable purgatives in suitable cases. It is especially indicated in habitual constipation due to languor of the colon, with low atonic dyspepsia and hypochondriacal despondent feelings. It improves instead of deranging digestion, and gains instead of losing its activity by repetition; its laxative effect is of a natural character, if its griping action be covered by carminatives as in most of the officinal preparations. It must, however, be avoided in irritable states of the rectum, hæmorrhoids, menorrhagia, and pregnancy, unless given with care. Aloes is an ingredient of almost all the compound pills in ordinary use for habitual constipation, *e.g.* of rhubarb, colocynth, and gamboge; and the extract is also given with extract of belladonna, nux vomica, sulphate of iron, or quinia, as a dinner-pill. The compound decoction is perhaps the best preparation of the drug, being particularly valuable in the constipation of children with hard motions, vermes, indigestion, acidity, and derangement of the general health.

The action of aloes on the pelvic circulation constitutes it a uterine stimulant, and it is given with success as the Aloes and Myrrh Pill in the amenorrhœa of young women, so often associated with chronic constipation and dyspepsia. The Aloes and Iron Pill is perhaps the most valuable of all remedies in the anæmia, amenorrhœa, and constipation of girls at and after puberty. Enema Aloes is anthelmintic.

2. ACTION IN THE BLOOD; SPECIFIC, AND REMOTE LOCAL ACTION.

Aloin enters the blood and tissues, and is excreted at least in the milk.

MELANTHACEÆ.

Veratri Viridis Radix — GREEN HELLEBORE ROOT.—The dried rhizome of Veratrum viride. Collected in autumn in the United States and Canada.

Characters.—Slices, fragments, or conical truncated entire pieces, earthy, black outside, light within; with numerous yellowish radicles attached to it. When dry it is inodorous. Taste at first sweet, then bitter, followed by a persistent acrid burning sensation in the mouth.

Substances resembling Veratrum Viride: Valerian, Serpentary, and Arnica (q.v.). Veratrum has thicker rootlets.

Composition.—Veratrum viride contains a mixture of alkaloids, which have been variously separated and named by different pharmacologists, *veratria*, *veratroidin*, and *jervin*.

Preparation.

Tinctura Veratri Viridis.—1 in 5. *Dose*, 5 to 20 min.

Sabadilla — CEVADILLA. — The dried fruit of Asagræa officinalis. Imported from Mexico.

Characters.—Fruit about half an inch long, consisting of three light brown papyraceous follicles, each containing from one to three seeds, which are about a quarter of an inch long, blackish-brown, shining, slightly winged, possessing an intensely acrid bitter taste.

Composition.—The active constituent of sabadilla is *veratria*.

From Sabadilla is made:

Veratria, $C_{32}H_{52}N_2O_8$.—An alkaloid obtained from Cevadilla; not quite pure.

Source.—Obtained from Cevadilla by (1) making and concentrating a tincture of the seeds; (2) pouring into water to precipitate the albumen, and filtering; (3) precipitating crude veratria from the filtrate by NH_4O, and washing; (4) purifying by solution in HCl, digestion with charcoal, reprecipitation with NH_4O, filtration, washing, and drying.

Characters.—Pale grey, amorphous, odourless, but very irritant to nostrils; strongly and persistently bitter, and acrid; insoluble in water, soluble in spirit.

Dose, $\frac{1}{70}$ to $\frac{1}{16}$ gr., carefully divided in pill.

Preparation.

Unguentum Veratriæ.—8 gr. to 1 oz. Lard, with Olive Oil ½ fl.dr.

ACTION AND USES.

1. LOCAL ACTION AND USES.

Externally, green hellebore and veratria are first powerfully **irritant and then depressant** to the nerves and vessels, causing pricking, burning sensations, and redness of the skin, followed by loss of sensibility and vesication. Unguentum Veratriæ is therefore applied to relieve neuralgic and rheumatic pains, but the alkaloid is absorbed by the unbroken skin, and may produce its powerful specific effects.

Inhaled or sniffed into the nose, these substances cause violent sneezing and cough, manifestly from irritation of the nerves. No use is made of this property.

Internally, reflex salivation, dysphagia, epigastric heat and pain, vomiting, and diarrhœa, indicate the irritant effect of veratrum viride and veratria on the alimentary canal. They are never given as emetics.

2. ACTION ON THE BLOOD.

Veratria enters the blood rapidly from the skin or mucous surfaces. Leucocytes (out of the body) are paralysed or killed by dilute solutions of the alkaloid.

3. SPECIFIC ACTION.

Veratria may be found in the various organs after administration. Full doses produce, in addition to the painful vomiting of local origin, great muscular prostration, faintness, and finally collapse, preceded and accompanied by a slow feeble or irregular pulse, feeble respiration, cold sweats, fall of temperature, occasional muscular twitching and creeping, and itching sensations on the skin. It has now been proved that these phenomena are not referable to the *cerebrum*, which remains unaffected, with perfect consciousness, nor to the motor centres of the *cord* or *motor* nerves, all of which are but slightly depressed. **The muscles are the organs attacked by veratria**, which produces a highly remarkable lengthening of the contraction, the descending portion of the muscle curve (phase of relaxation) being fifty times its ordinary length. Therewith the force of the contraction is increased. These two effects on the muscle contraction are so marked that the muscle appears to be in a state of tetanus, but the curve is really a single contraction, and not compound or a fusion of closely repeated simple spasms. Larger doses cause weakness of the muscles and finally paralysis.

The heart, after primary acceleration, is affected just like the voluntary muscles, its contractions becoming greatly lengthened, and thus its **frequency reduced** (even by 20 to 60 beats per minute in fever), long pauses occurring at the end of systole. Irregularity, acceleration with feebleness, and finally paralysis are the result of larger doses. The *blood pressure* rises at first, falls during the stage of infrequency, and is then dangerously lowered. The primary stimulation of the heart and vessels, and part of the succeeding depression, occur through the centres in the medulla.

Respiration is first accelerated, then slowed, and finally arrested through the centre, the muscles, and the pulmonary vagus; the movements exhibiting expiratory pauses and irregularity.

The fall of *temperature*, which may amount to several degrees in fever, appears to be referable to the circulatory failure.

4. SPECIFIC USES.

The specific uses of veratria depend on its **depressing action on the heart, vessels, and body temperature**; that is, it is a powerful antipyretic. It has been recommended for the same conditions as aconite, namely, acute febrile processes in strong subjects, such as sthenic pneumonia and acute rheumatism. If it be considered safe and desirable to treat such cases with powerfully depressant measures, veratria may be used; but in England, at least, the opposite line of treatment is generally followed, and every lowering influence on the heart carefully avoided. In aneurism and in hæmorrhage, where the blood pressure has to be reduced, veratria cautiously given, or the Tinctura Veratri Viridis, may be of much service.

5. REMOTE LOCAL ACTION.

Veratria quickly appears in the urine, being excreted by the kidney.

Colchici Cormus—COLCHICUM CORM. — The fresh corm of Colchicum autumnale; collected about the end of June; and the same stripped of its coats, sliced transversely, and dried at a temperature not exceeding 150°.

Characters.—Fresh corm about the size of a chestnut, flattened where it has an undeveloped bud; furnished with an outer brown and an inner yellow coat; internally white, solid and fleshy; yielding when cut a milky acrid and bitter juice. Dried slices about a line thick, moderately indented on one, rarely on both sides, firm, flat, whitish, amylaceous.

Substances somewhat resembling Colchicum: Tragacanth and Squill, which have different texture, and are not kidney-shaped.

Dose.—2 to 8 gr. in powder.

Colchici Semina—COLCHICUM SEEDS. — The fully ripe seeds of Colchicum autumnale.

Characters.—About the size of white mustard seed, very hard, and of a reddish-brown colour.

Substance resembling Colchicum Seeds: Black Mustard, which is smaller.

Composition. — Colchicum contains an active principle, *colchicin*, $C_{17}H_{19}NO_5$, an amorphous, yellowish, bitter alkaloid; with tannic and gallic acids, starch, sugar, gum, etc.

Preparations.

A. *Of Colchici Cormus:*

1. **Extractum Colchici.**—25 in 1. The expressed juice of *fresh* Colchicum Corms, decanted from deposit; heated to 212° Fahr. to coagulate albumen; strained; and evaporated. *Dose*, 1 to 3 gr.
2. **Extractum Colchici Aceticum.**—18 in 1. Made like the simple extract, Acetic Acid being first added to the crushed corms. *Dose*, ½ to 2 gr.
3. **Vinum Colchici.**—1 *dried* in 5. *Dose*, 10 to 30 min.

B. *Of Colchici Semina:*

Tinctura Colchici Seminum.—1 in 8. *Dose*, 10 to 30 min.

ACTION AND USES.

The physiological action of colchicum is imperfectly understood, and affords but a partial explanation of its empirical use.

Given *internally* it is a **gastro-intestinal irritant**, acting as an emetic and purgative in full doses, the stools containing a decided increase of bile, partly referable to a direct cholagogue effect of the drug. Colchicin appears to enter the blood and tissues, and here acts chiefly upon the central nervous system. The convolutions and spinal cord are depressed, large doses causing loss of sensibility and consciousness, and diminished reflex excitability. The peripheral sensory nerves are also paralysed, but the motor nerves and muscles remain unaffected. The respiratory centre is lowered in activity, and death occurs by asphyxia. The heart is weakened, the pulse even becoming intermittent; but this effect is believed to be entirely secondary to the disturbance of the respiration. The kidneys are hyperæmic, and the amount of urine diminished; the uric acid and probably the urea are reduced in quantity. The **skin perspires** more freely.

Colchicum is chiefly used to relieve the pain and inflammation, and shorten the duration, of **acute gout**, for which purpose it is usually given in doses short of producing the above physiological effects, so that the mode of its action is quite obscure. It is most successful in first attacks in young robust subjects; less useful, and to be used with caution, in the chronic gout of old weakly individuals; and occasionally it completely fails to afford any relief. It is generally prescribed with alkaline purgative salines. In some acute gouty affections of other parts than the joints, such as bronchitis, hepatic congestion, neuralgia, and urethritis, colchicum occasionally relieves. It is worse than useless in rheumatism. The extract may be added to purgative pills as a cholagogue.

PALMACEÆ.

Areca—ARECA NUT.—The seed of Areca Catechu, the Betel Nut Tree. Imported from the East Indies.

Characters.—The nuts are about the size of a nutmeg, but less wrinkled and more globular, and not aromatic; reddish-brown externally, having a flattened base and somewhat conical apex. The interior is hard, dark brown, finely marbled with white. Inodorous, with astringent taste.

Composition.—Areca contains *catechu, tannic and gallic acids, areca-red, gum*, and *oily matter.*

Dose.—$\frac{1}{2}$ to $\frac{3}{4}$ oz.

ACTION AND USES.

Areca nut is **astringent and anthelmintic**, and has been used in diarrhœa and helminthiasis. It is rarely given.

GRAMINACEÆ.

Farina Tritici—WHEATEN FLOUR.—The grain of Wheat, Triticum vulgare, ground and sifted.

Characters.—Familiar.

Composition.—Flour consists chiefly of *gluten* and *starch*, with gum, sugar, mucilage, and water.

From Farina Tritici is made :

Mica Panis.—Crumb of Bread.

Mica Panis is contained in Cataplasma Carbonis.

Farina Tritici is also contained in Cataplasma Fermenti.

Amylum—STARCH. $C_6H_{10}O_5$. — The Starch procured from the seeds of common wheat, Triticum vulgare.

Characters and tests.—In white columnar masses. When rubbed in a Wedgwood mortar with a little cold distilled water, it is neither acid nor alkaline to test-paper, and the filtered liquid does not become blue on the addition of solution of iodine. Mixed with boiling water and cooled, it gives a deep blue colour with iodine.

Preparations.

1. **Glycerinum Amyli.**—1 part to 8 by measure; made by heating the mixture to 240° ; a jelly-like preparation.
2. **Mucilago Amyli.**—1 in 40.

Amylum is also contained in Pulvis Tragacanthæ Compositus (1 in 6).

ACTION AND USES.

Starch is a **nutritive** material of the first order, but is introduced into the Pharmacopœia for medicinal and pharmaceutical purposes only. *Externally* it is **protective and absorbent,** in the form of "dusting powder" for delicate or diseased conditions of the skin. The glycerinum is an excellent basis for ointments. *Internally* the mucilage is the **vehicle** of all the officinal Enemata, except those of tobacco and assafœtida. It is also an **antidote** in poisoning by iodine, but must be followed by an emetic.

Hordeum Decorticatum—PEARL BARLEY.—The husked seeds of Hordeum distichon. Cultivated in Britain.

Characters.—White, rounded, retaining a trace of the longitudinal furrow.

Composition.—Barley consists of *starch*, *gluten*, *sugar*, *gum*, etc.

Preparation.

Decoctum Hordei. "Barley Water."—1 to 15 of water.

ACTION AND USES.

Barley water is **nutritive and demulcent**, and is chiefly used in inflammatory affections of the throat, and respiratory and urinary organs.

Malt Extract—MALTINE. (*Not Officinal.*) — A syrupy yellowish-brown fluid, with a sweet taste; made by acting on malt, or a mixture of malt and flour, by water, at a temperature not exceeding 124° Fahr.

Composition.—Malt extract consists chiefly of *dextrin* and *maltose*. Good specimens have active diastatic properties, *i.e.* will convert several times their bulk of starch into sugar.

Dose.—1 to 4 dr.

ACTION AND USES.

Malt extract is, both directly and indirectly, **nutritive**, containing, as it does, not only food elements, but also active diastase, which converts the starch of bread and other farinas into sugar. It is used in wasting diseases. As diastase is only active in alkaline fluids, it must be given not less than two hours after a meal, when the acid of the stomach is exhausted. Or it may be mixed with warm food a short time before the latter is taken. Maltose is a form of sugar which does not ferment, and will not give rise to acidity and dyspepsia.

Ergota—ERGOT.—The sclerotium (compact mycelium or spawn) of Claviceps purpurea, produced within the paleæ of the common Rye, Secale cereale.

Characters.—Subtriangular, curved, with a longitudinal furrow on the concave side, obtuse at the ends; from one-third of an inch to an inch and a half in length; of a violet-brown colour on the surface, pinkish within; solid, frangible, fracture short; odour faintly marked, but strong if the powder be triturated with solution of potash.

Composition.—The chemical composition of ergot has always been a subject of difficulty, and cannot be said to be yet settled. Ergot is now generally believed to contain three important bodies: 4 per cent. of *sclerotic acid*, 2½ per cent. of *scleromucin*, and *colouring matter*. Besides these, there occur in it 30 per cent. of a *fixed oil*, cholesterin, cellulose, mannite, lactic acid, abundance of potash salts, methylamin, trimethylamin, leucin, and several unimportant alkaloids. *Sclerotic acid*, $C_{12}H_{19}NO_9$, is a brownish hygroscopic substance without odour or taste, acid, forming salts readily soluble in water, and possessing the physiological action of the ergot itself. *Scleromucin* is a colloidal gummy-like mass, without odour or taste, soluble in water. It contains nitrogen, and has the same physiological action as sclerotic acid, but less marked. The *colouring matter* is also feebly active physiologically; it consists of several bodies, named *sclererythrin*, *scleroxanthin*, etc. The "ergotin" of manufacturers is an extract of the drug, not any of the active principles in a separate form.

Dose.—20 to 30 gr. *Of "Ergotin" hypodermically*, 1 to 3 gr.

Preparations.

1. **Extractum Ergotæ Liquidum.**—1 in 1, after washing with Ether. *Dose*, 15 to 30 min.
2. **Infusum Ergotæ.**—1 in 40. *Dose*, 1 to 2 fl.oz.
3. **Tinctura Ergotæ.**—1 in 4. *Dose*, 15 to 60 min.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

In large doses ergot is a gastro-intestinal irritant, but moderate doses may be given almost indefinitely without interfering with the stomach or bowels.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION.

The active principles of ergot enter the blood, but exert no appreciable change on it. Thence they pass into the tissues and organs, and set up well-marked symptoms, if given in full doses for a sufficient time. The parts chiefly affected are the central nervous system, respiration, circulation, intestines, and uterus. The highest centres (cerebral) are not directly influenced by ergot. **The spinal cord is distinctly affected,** a series of nervous phenomena being the result during life, and definite changes found in the posterior (Burdach's) columns after death. The patient first complains of creeping sensations in the limbs, as if an insect were running along the skin; sudden painful cramps or twitching of the legs follows; the gait becomes staggering (ataxic); and convulsions, with loss of sensibility and motion, may follow. These spinal effects are chiefly seen in cases of chronic "ergotism," where the drug has been consumed in large quantity in rye bread; but they indicate its mode of action, and may be met with clinically. The motor and sensory nerves and muscles are themselves unaffected. Respiration becomes infrequent after large doses, and death occurs by asphyxia. **The heart is reduced in frequency** by ergot, sometimes twenty to thirty-six beats per minute, and becomes feeble and irregular at last, possibly through the vagus, more probably through failure of the ganglia and want of venous charge. **The arteries become distinctly smaller** under ergot —according to some authorities, by vaso-motor stimulation; according to other authorities, by active venous dilatation, which drains the blood from the arteries, and causes them passively to contract. **The blood pressure falls steadily.** The intestine is peculiarly blanched under ergot, and consequently excited to peristaltic movements. **The uterus** becomes similarly anæmic, and **contracts actively,** especially if pregnant, and still more if parturition have commenced, when long and powerful pains are developed. These effects of ergot on the bowels and womb have been also referred to stimulation of their spinal centres. The body temperature falls. Gangrene frequently results from the protracted use of ergotised meal as an article of diet.

3. SPECIFIC USES.

Ergot is used chiefly to control hæmorrhage and to excite or increase uterine contraction. As a **hæmostatic,** acting apparently by lowering the blood pressure, it is extensively employed in hæmoptysis, hæmatemesis, menorrhagia, and intestinal hæmorrhage, where the hypodermic injection of ergotin is rapid and effective, unless it alarm the patient and excite movement and palpitation, when it is better avoided. In aneurism it may be combined with rest and low diet to promote consolidation in the sac. The use of ergot in the second stage of labour should be confined to cases of uterine inertia where there is no obstacle in the passages; so frequently is this **ecbolic** abused, that it is calculated more harm than good has resulted from the discovery of its action in parturition. After the completion of the second stage, ergot may be more safely given to expel the placenta and clots, and ensure contraction of the womb; whilst in *post partum* hæmorrhage it is an invaluable adjuvant to more immediate remedies. In polypus uteri, chronic metritis, sub-involution, etc., ergot is also used with success. The action of ergot on the spinal cord suggests its rational application in paraplegia of inflammatory origin, sclerosis, etc., and instances of recovery under its influence are recorded. It has also been used in recurrent mania, referable to cerebral hyperæmia.

4. REMOTE LOCAL ACTION AND USES.

Ergot **reduces the amount of the urine, sweat, and milk,** more probably, however, through the blood pressure and the nervous centres of the glands in the brain and cord, than by direct action on the excreting cells. It is a valuable remedy in some cases of polyuria (diabetes insipidus), very rarely in saccharine (true) diabetes. The sweats of phthisis are said to be controlled by ergot. As an antigalactagogue it is but seldom employed.

Saccharum Purificatum—REFINED SUGAR.—

$C_{12}H_{22}O_{11}$. Pure cane sugar prepared from the juice of the stem of Saccharum Officinarum. From plants cultivated in the West Indies and other tropical countries.

Characters.—Compact crystalline conical loaves, known in commerce as lump sugar. 100 parts are soluble in 45 of water or 10,000 of rectified spirit. It increases the solubility of lime in water. See *Liquor Calcis Saccharatus*, page 50.

Preparation.

Syrupus.—1 in $1\frac{1}{6}$.

Sugar or Syrup is contained in all syrups and lozenges, several confections, and various mixtures, pills, powders, etc.

ACTION AND USES.

Sugar is **nutrient and demulcent**, but is chiefly used in medicine to cover the taste of other drugs.

Theriaca—TREACLE (SACCHARI FÆX).—The uncrystallised residue of the refining of sugar.

Characters.—A thick brown fermentable syrup, very sweet.

Theriaca is an ingredient of a number of pills.

ACTION AND USES.

Treacle is **demulcent, nutrient, and slightly laxative**, and is employed in pharmacy to make pills.

Coto Bark—CORTEX VERUS. **Paracoto Bark**—CORTEX PARA. (*Not Officinal.*)—The barks of two allied trees, from Bolivia.

Characters.—Coto bark resembles cinchona bark, with an aromatic resinous odour, and a pungent taste.

Composition.— Coto verus contains *cotoïn*, $C_{22}H_{18}O_6$, yellowish, amorphous or finely crystalline, with a balsamic odour and a bitter taste; nearly insoluble in water, soluble in spirit. Para bark contains *paracotoïn*, $C_{19}H_{12}O_6$, in minute pale crystals; insoluble in water.

Dose.—Of coto in powder, 1 to 8 gr.; of cotoïn, ½ to 2 gr.; of paracotoïn, 1½ to 3 gr.

Non-officinal Preparations.

Cotoïn; Paracotoïn; and a Tincture, given in doses of 10 min.

ACTION AND USES.

The only physiological effect of coto is as an **intestinal astringent.** It is useful in some cases of persistent subacute diarrhœa, as in phthisis and delicate subjects.

FILICES.

Filix Mas—MALE FERN.—The dried rhizome, with the bases of the footstalks and portions of the root fibres, of Aspidium Filix mas. Collected in summer.

Characters.—Tufted, scaly, greenish brown; powder greenish-yellow, with a disagreeable odour, and a nauseous, bitter, somewhat astringent taste.

Preparation.

Extractum Filicis Liquidum.—"Oil of Male Fern." Male Fern, 1; Ether, 2½. Percolate, and distil off the ether. *Dose,* 30 to 60 min.

Composition.—Male fern contains a colourless crystalline body, *filicic acid,* fixed and volatile oils, tannin, resins, and the ordinary constituents of plants. Which may be the active principle is uncertain.

ACTION AND USES.

Male fern is an active **anthelmintic**, peculiarly destructive to the tape-worm. It is less irritant to the stomach and bowels than cusso and kamala, and should be preceded and followed by a purgative. It is, on the whole, the most successful of anthelmintics when properly employed.

LICHENES.

Cetraria—ICELAND MOSS.—The entire lichen, Cetraria islandica. Native of the north of Europe.

Characters.—Foliaceous, lobed, crisp, cartilaginous, brownish-white, paler beneath; taste bitter, and mucilaginous. A strong decoction gelatinises on cooling.

Composition.—Cetraria contains 10 per cent. of *starch;* 20 per cent. of *lichenin,* $C_6H_{10}O_5$, a starch-like powder, not striking blue with iodine; and two bitter acids—*cetraric acid,* $C_{17}H_{16}O_8$, and *lichenstearic acid,* $C_{14}H_{24}O_3$.

Preparation.

Decoctum Cetrariæ.—1 to 20. *Dose,* 1 to 2 fl.oz.

ACTION AND USES.

Iceland moss is at once a **bitter tonic** and **nutritive** substance, but is not in general use as either.

Litmus.—A blue pigment prepared from various species of Roccella.

Characters.—Small blue lumps, readily reduced to powder.

Preparations.

1. **Tincture of Litmus.**—1 in 10.
2. **Blue Litmus Paper.**
3. **Red Litmus Paper.**

USE.

Litmus is employed only in chemical testing.

Cerevisiæ Fermentum—BEER YEAST.—The ferment obtained in brewing beer.

Characters.—Viscid, semi-fluid, frothy, exhibiting under the microscope numerous round or oval confervoid cells.

Dose.—One to two table-spoonfuls.

Preparation.

Cataplasma Fermenti.—Yeast Poultice. Yeast, 6; Flour, 14; Water (at 100°), 6. The mass to be placed near the fire till it rises.

ACTION AND USES.

Yeast poultice is believed to act as a **sedative and antiseptic**, and was formerly applied to sloughing sores, ulcers, and boils. Its value is very questionable.

Yeast has also been given internally on theoretical grounds in zymotic diseases and in diabetes, but probably without success.

FUNGI.

Muscariæ Nitras.—(*Not Officinal.*)—Nitrate of Muscarin, the liquid alkaloid of Agaricus muscarius or Amanita muscaria, the Fly Agaric.

Dose.—$\frac{1}{30}$ to $\frac{1}{3}$ gr.

ACTION AND USES.

The action of muscaria is almost exactly opposed to that of atropia in every respect, except that it dilates the pupil when applied locally. It also **contracts the pulmonary vessels.** It has been used as an **anhidrotic.**

GROUP II.

THE ANIMAL KINGDOM.

RODENTIA.

Castoreum — Castor. — The dried preputial follicles and their secretion, obtained from the Beaver, Castor Fiber, and separated from the somewhat shorter and smaller oil-sacs which are frequently attached to them. From the Hudson's Bay Territory.

Characters.—Follicles in pairs, about three inches long, fig-shaped, firm, and heavy, brown or greyish-black; containing a dry resinous reddish-brown or brown highly odorous secretion, in great part soluble in rectified spirit, and in ether.

Impurities.—Spurious sacs, filled with dried blood, etc.

Composition.—Castor contains, in addition to the ordinary constituents of animal secretions, such as salts, a *volatile oil*, *uric*, *carbolic* and *benzoic acids*, *salicin*, and *fixed oils*.

Dose.—5 to 10 gr.

Preparation.

Tinctura Castorei.—1 in 20. *Dose*, $\frac{1}{2}$ to 1 fl.dr.

ACTION AND USES.

The action of castor is **stimulant** like that of musk. The drug is very seldom used.

RUMINANTIA.

Moschus—Musk.—The inspissated and dried secretion from the preputial follicles of Moschus moschiferus; native of the mountainous regions of Central Asia. Imported from China and India.

Characters.—In irregular, reddish-black, rather unctuous grains; having a strong, peculiar, very diffusible odour, and a bitter aromatic taste; contained in a round or slightly oval membranous sac, about two inches in diameter, covered on the outer side with stiff greyish hairs arranged in a concentric manner around its central orifice.

Composition.—Musk contains an *aromatic principle*, the chemical nature of which is unknown, and a quantity of inactive substances, such as salts, fixed oils, etc.

Dose.—5 to 10 gr.

ACTION AND USES.

Musk is a powerful **stimulant** of the circulatory and nervous organs, acting probably much like turpentine and other volatile oils, *i.e.* chiefly reflexly from the nose, mouth, and stomach. It appears to enter the blood and tissues, and there rapidly causes depression, so that in full doses its stimulant effect is extremely evanescent. The drug is now but seldom used, chiefly as an antispasmodic in hysteria, laryngismus, and hiccup, and as a stimulant in fevers and pneumonia, when other measures have failed, and not then with much success.

Sevum Præparatum—PREPARED SUET.—The internal fat of the abdomen of the sheep, Ovis Aries, purified by melting and straining.

Characters.—White, smooth, almost scentless; fusible at 103°.

Composition.—Suet is composed of *olein* and *stearin.* See *Adeps Præparatus.*

Preparation.

Sapo Animalis.—Curd Soap. Made with Soda and Prepared Fat. *Contained in* several suppositories, and Pilula Scammonii Composita.

Suet is also contained in Emplastrum Cantharidis and Unguentum Hydrargyri.

ACTION AND USES.

Suet is **emollient,** and used in the above preparations. Internally it is **nutritive.**

Saccharum Lactis—SUGAR OF MILK. $C_{12}H_{24}O_{12}$. A crystallised sugar, obtained from the whey of Milk by evaporation.

Characters.—Usually in cylindrical masses, two inches in diameter, with a cord or stick in the axis, or in fragments of cakes; greyish-white, crystalline on the surface and in its texture, translucent, hard; scentless, faintly sweet, gritty when chewed. Readily soluble in water.

Substance, resembling Sugar of Milk: Acid Tartrate of Potash, known by taste, and without central cord.

ACTION AND USES.

Sugar of milk is less hygroscopic than ordinary sugar, and is thus more suitable as a **vehicle** for heavy powders. It is also used to sweeten preparations of milk for artificially fed infants.

Fel Bovinum Purificatum—PURIFIED OX BILE.—The purified gall of the Ox, Bos Taurus.

Source.—Prepared by agitating fresh ox bile with twice its volume of rectified spirit; separating the sediment of mucus; and evaporating the clear solution to the consistence of an extract.

Characters and tests.—A yellowish-green substance, having a taste partly sweet and partly bitter, soluble in water and in spirit.

Impurity.—Mucus, giving a precipitate with rectified spirit in watery solution.

Composition.—Purified ox bile has the composition of fresh bile, less the mucus removed by the rectified spirit.

Dose.—5 to 10 gr.

ACTION AND USES.

The action of bile in the duodenum is familiar, but when admitted into the stomach it is apt to cause vomiting, neutralising the gastric juice, precipitating the pepsin, and being itself rendered inactive. It was introduced as a bitter and **cholagogue purgative**, but is obviously of doubtful value. It may be used as a basis for aperient pills.

Pepsina—PEPSIN.—A preparation of the mucous lining of the fresh and healthy stomach of the Pig, Sheep, or Calf.

Source.—Made by scraping the cleansed mucous membrane; drying the viscid pulp on a glass surface at 100°; and pulverising.

Characters.—A light yellowish-brown powder having a faint, but not disagreeable odour, and a slightly saline taste, without any indication of putrescence. Very slightly soluble in water or spirit. Digests albumen.

Dose.—2 to 5 gr.

ACTION AND USES.

Pepsin is one of the normal constituents of the gastric juice, converting albumen into peptone with the assistance of the hydrochloric acid. The same effect is produced out of the body, or in other cavities such as the rectum.

Pepsin is extensively used as an **aid to digestion** either alone in the solid form, or combined with diluted hydrochloric acid, being given during or after meals. It is especially indicated and successful in morbid conditions of the stomach associated with deficiency of the gastric juice—whether from disease of the follicles, such as atrophy; excess of mucus, as in the chronic catarrhal dyspepsia of alcoholism, deficient blood supply, as in anæmia and general debility; or irritable states of the stomach with pain and vomiting, such as ulcer and cancer, where the normal stimulation of the mucous membrane must be avoided, and fluid food only given. Pepsin is also useful in the dyspepsia of the aged, and of infants. The principal objections to its use are the uncertainty of its strength and action, and the danger of allowing the gastric function to become obsolete.

Pepsin is a valuable addition to **nutritive enemata**, the natural digestive power of the secretion of the rectum being comparatively small.

Pepsin has also been used as a local application to dissolve the membrane in diphtheria, and even to promote the absorption of tumours.

Liquor Pancreaticus.—(*Not Officinal.*)—An aqueous and spirituous extract of the fresh pancreas of the Pig.

ACTION AND USES.

Preparations of the pancreas are active **digestives of proteids and amyloids,** and are used with great success to peptonise milk, gruel, and soups before administration in cases of digestive debility. They are not suited for separate internal use.

PACHYDERMATA.

Adeps Præparatus—PREPARED LARD.—The purified fat of the Hog, Sus scrofa.

Characters and tests.—A soft white fatty substance, melting at about 100°. Has no rancid odour. Dissolves entirely in ether.

Impurities.—Common salt and starch.

Composition.—Lard consists of 60 per cent. of *olein*, and some *palmitin* and *stearin*. Olein is a fluid oil, a compound of oleic acid, $C_{18}H_{33}O_2$, and glyceryl, C_3H_5. Palmitin and stearin are solid oils, compounds of glyceryl with palmitic acid ($C_{16}H_{32}O_2$), and stearic acid ($C_{18}H_{36}O_2$) respectively.

Preparations.

1. **Adeps Benzoatus.**—1 of Benzoin in 64 of Lard.
2. **Unguentum Simplex.**—3 in 8, with White Wax and Almond Oil.

Either Lard or Benzoated Lard is contained in almost all ointments.

ACTION AND USES.

Lard is a simple **emollient**, forming the basis of most of the officinal ointments. Benzoated lard does not become rancid like ordinary lard, which for the same reason is now in a measure replaced by vaseline.

CETACEA.

Cetaceum—SPERMACETI.—Nearly pure cetine, obtained, mixed with oil, from the head of the Sperm Whale, Physeter macrocephalus, inhabiting the Pacific and Indian Oceans. It is separated from the oil by filtration and pressure, and afterwards purified.

Characters.—Crystalline, pearly white, glistening, translucent, with little taste or odour, reducible to powder by the addition of a little rectified spirit. Scarcely unctuous to the touch; does not melt under 100°.

Substance resembling Spermaceti: White Wax, known by general appearance and hardness.

Composition.—Spermaceti is a fat, containing as its base, not glycerin but *cetylalcohol*, in combination with palmitic acid. $C_{16}H_{33}O.C_{16}H_{31}O$.

Preparations.

Unguentum Cetacei.—About 1 in 5, with White Wax and Almond Oil.

Cetaceum is used in preparing Charta Epispastica.

USE.

Spermaceti is an **emollient**, and is also employed pharmaceutically.

AVES.

Albumen Ovi—EGG ALBUMEN.—The liquid white of the egg of Gallus Banckiva, *var.* domesticus.

Composition.—White of egg contains 86 per cent. of water, and 14 per cent. of solids, chiefly albumen, with a little fat, sugar, and sulphates.

ACTION AND USES.

White of egg is **demulcent and nutritive**, of value in some cases of irritability of the stomach. It is also a valuable **antidote** in poisoning by corrosives and irritants, especially perchloride of mercury, sulphate of copper, lead, and nitrate of silver.

Ovi Vitellus—YOLK OF EGG.—The yolk of the egg of Gallus Banckiva, *var.* domesticus.

Composition.—Yolk of egg contains 16 per cent. of *albumin*, and a modification of it called *vitellin* (not precipitated by lead or copper); 30 per cent. of fatty bodies containing phosphorus and colouring matter, soluble in ether; *salts*; and *water*.

Preparation.

Mistura Spiritus Vini Gallici.—Egg Flip. The Yolks of 2 Eggs; Brandy, 4 fl.oz.; Cinnamon Water, 4 fl.oz.; Refined Sugar, ½ oz. *Dose*, 1 to 2 fl.oz.

ACTION AND USES.

Yolk of egg is highly **nutritive**, and the Mistura Spiritus Vini Gallici is a very valuable food and stimulant in conditions of extreme exhaustion.

PISCES.

Isinglass—The swimming bladder or sound of various species of Acipenser, prepared and cut into fine shreds.

Characters.—Light, coriaceous, whitish or yellowish, semi-transparent, inodorous, tasteless; insoluble in cold water, soluble in 24 parts of boiling water, forming a transparent jelly on cooling.

From Isinglass is made: Solution of Gelatine.

USE.

Isinglass is **nutrient,** Gelatine is **used in chemical testing.**

Oleum Morrhuæ—Cod-Liver Oil.—The oil extracted from the fresh liver of the cod, Gadus Morrhua, by the application of a heat not exceeding 180°.

Characters and test.—Pale yellow, with a slight fishy odour, and bland fishy taste. A drop of sulphuric acid added to a few drops of the oil on a porcelain slab develops a violet colour, which soon passes to a yellowish or brownish-red.

Composition.—Cod-liver oil consists chiefly of olein and margarin, but contains as much as 5 per cent. of free fatty acids (oleic, palmitic, stearic), traces of iodine and bromine, the ordinary inorganic salts of animal tissues and products, and trimethylamin $N(CH_3)_3$. Some authorities give bile as a constituent of cod-liver oil, others deny this entirely.

Impurities.—Inferior oils.

Dose.—1 to 8 fl.dr.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

The action and uses of oils externally have been fully discussed under the head of *Oleum Olivæ*, page 284.

Cod-liver oil is sometimes rubbed into the skin of wasting children as a nutrient, and with perfect success; but it imparts an objectionable colour and smell to the body.

With a little perseverance, it is as easily taken as other oils, and more easily digested, on account of the amount of free acid which it contains, and which greatly facilitates saponification and emulsion, as well as absorption.

2. ACTION ON THE BLOOD.

Like olive and other oils, it enters the circulation, carrying with it traces of the other constituents. Increasing the richness of the chyle, it improves the quality of the blood, especially as regards the corpuscles, and is thus a **hæmatinic.**

3. SPECIFIC ACTION AND USES.

Passing into the cells, cod-liver oil is a nutrient of the first importance, whilst the traces of iodine, bromine, phosphates, other salts, and the trimethylamin doubtless produce a slight specific action when the oil is given continuously for months. The latter effects are, however, quite secondary to those of the oil proper, that is, to its effects as **a food.** Thus cod-liver oil differs from other oils (olive and almond oils, cream, butter, etc.), chiefly, but not solely, in respect of the ease with which it is digested and absorbed.

Cod-liver oil is very extensively used in almost all kinds of chronic disease attended by wasting. The chief of these diseases are scrofula in its various forms, phthisis, rickets, tertiary syphilis, chronic rheumatism, and general debility referable to misery, over-work, and under-feeding. In convalescence from acute illness it is of much service. It is also one of the best restoratives of the nervous functions, and of great value as a tonic in neuralgia, headache, mental irritability, despondency, and other less definite disorders, referable to exhaustion or inherent debility of the nervous centres.

In every instance where cod-liver oil is indicated, the first point to be determined is whether it can be taken and digested. Besides the difficulty of taste, two conditions distinctly contraindicate the exhibition of the oil, namely, diarrhœa and considerable fever. Gastric dyspepsia also suggests hesitation in the use of oil, but if alkaline stomachics are given before meals, and the oil after, it will be found to agree perfectly in most cases. If oil be persistently rejected, it should be stopped for a time, and again cautiously tried, or given with ether (10 minims of pure ether to 1 drachm of oil) or as an emulsion.

HYMENOPTERA.

Mel—HONEY.—A saccharine secretion deposited in the honeycomb, by Apis mellifica, the Hive Bee.

Characters and test.—When recently separated from the honeycomb, it is a viscid translucent liquid, of a brownish yellow colour, which gradually becomes partially crystalline and opaque. Has a peculiar heavy odour, and very sweet taste.

Impurity.—Starch.

Composition.—Honey is a complex mixture of several kinds of *sugar* (cane and grape sugar, levulose or inverted sugar, derived by fermentation from the cane sugar); wax, pollen, colouring and odorous matters, etc.

Preparations.

Mel Depuratum.—Made by melting and straining.

From Mel Depuratum is prepared:

Oxymel.—8, with Acetic Acid, 1, and Water, 1.—*Dose*, 1 to 2 fl.dr.

Honey is also contained in Mel Boracis, Oxymel Scillæ, Confectio Piperis, Confectio Scammonii, and Confectio Terebinthinæ.

ACTION AND USES.

Honey increases the secretions of the mouth and throat, and thus acts as an **emollient**, relieving dryness, pain, cough and dysphagia. It is a popular ingredient of gargles, linctuses and cough mixtures, but to be useful must be properly employed as the oxymel, or in combination with lemon, which has a similar action on the mouth and pharynx. As a vehicle for borax it is used in aphthæ of the mouth, but is inferior to glycerine because fermentable. Honey is also **laxative** and **nutritive.**

Cera Alba—White Wax.—Yellow wax bleached by exposure to moisture, air, and light.

Characters.—Hard, nearly white, translucent. Not unctuous to the touch; does not melt under 150°.

Cera Flava—Yellow Wax.—The prepared honeycomb of the Hive Bee, Apis mellifica.

Characters.—Firm, breaking with a granular fracture, yellowish, having an agreeable honey-like odour. Not unctuous to the touch; does not melt under 140°; yields nothing to cold rectified spirit, but is entirely soluble in oil of turpentine.

Impurity.—Starch.

Composition.—Wax differs from ordinary fats in containing, as its base, not glycerine, but another alcohol, *melisyl-alcohol*, in union with *palmitic acid*, $C_{30}H_{61}O.C_{16}H_{31}O_2$.

Preparations.

Yellow and White Wax are used in preparing many Plasters, Ointments, Suppositories, and Charta Epispastica.

USE.

Wax is used only for the **pharmaceutical purposes** just mentioned. If given internally, it passes out in the fæces entirely unabsorbed.

HEMIPTERA.

Coccus—COCHINEAL.—The dried female insect, Coccus Cacti. Reared in Mexico and Teneriffe.

Characters.—Ovate, plano-convex, about two lines long, wrinkled, black or greyish-white; yields, when crushed, a puce-coloured powder. The greyish-white insect quickly becomes black when warmed before the fire.

Impurities.—Inferior Cochineal is "faced" with various white or black powders to improve its appearance. It *resembles* Kino, which has an astringent taste.

Composition.—Cochineal contains a red colouring principle, *carmin* or *carminic acid*, brownish-purple, amorphous; readily soluble in water and spirit.

Preparations.

Tinctura Cocci.—1 in 8.—*Dose*, ½ to 1½ fl.dr.

Coccus is also an ingredient of Tinctura Cardamomi Composita, (60 gr. to 1 pint); and Tinctura Cinchonæ Composita, (30 gr. to 1 pint).

ACTION AND USES.

Cochineal is used as a **colouring material** only.

COLEOPTERA.

Cantharis — CANTHARIDES. — Cantharis vesicatoria. The Beetle, dried; collected chiefly in Hungary.

Characters.—From eight to ten lines long, furnished with two wing-covers of a shining metallic-green colour, under which are two membranous transparent wings; odour strong and disagreeable. Powder greyish-brown, containing shining green particles.

Substance resembling powdered Cantharis: Kamala, which has no shining particles.

Composition.—Cantharides contains ·20 to ·50 per cent. of *cantharidin*, a greenish *volatile oil*, and peculiar *fatty bodies*. Cantharidin, $C_{10}H_{12}O_4$, is obtained as shining colourless prisms, soluble in ether, chloroform, alcohol, and oils, and is the active principle, being a most powerful irritant. Some of the other properties of cantharides may possibly be referable to the oil.

Preparations.

1. **Acetum Cantharidis.**—1 in 10 of Glacial Acetic, and Acetic Acids.
2. **Charta Epispastica.**
3. **Emplastrum Cantharidis.**—1 in 3.
4. **Emplastrum Calefaciens.**—1 in 24.
5. **Liquor Epispasticus.**—Cantharides, 8; Acetic Acid, 4; Ether, to 20.
6. **Tinctura Cantharidis.**—1 in 80. *Dose*, 5 to 20 min.
7. **Unguentum Cantharidis.**—1 in 7.

ACTION AND USES.

1. IMMEDIATE LOCAL ACTION AND USES.

Externally.—Cantharis is a **rubefacient and vesicant** when applied to the skin, acting upon the nerves and vessels of the part like mustard and other measures of the same class, as described under *Sinapis*, to which the student is referred. Its effects differ from those of mustard chiefly in being much less rapid, but of a more severe degree. The Emplastrum or Charta has to be applied for a few hours before a sense of smarting, heat, and burning, is felt in the part; small vesicles then form, and at the end of eight to twelve hours have united into a single large bulla. The removal of the plaster after six hours, and the application of a poultice, will "raise the blister" more effectually and pleasantly. Vesication is decidedly more rapid after the application of the Acetum or Liquor Epispasticus. When the blister has been developed, the fluid is carefully incised, and the raw surface encouraged either to heal by simple dressing, or to discharge by the application of irritant ointments, such as Unguentum Sabinæ. Cantharis is the vesicant in ordinary use for purposes of counter-irritation.

Blisters are chiefly employed to control hyperæmia and the inflammatory process; to promote the absorption of morbid products; to relieve pain; and to arrest spasm and other reflex symptoms. The principle upon which they are believed to act is discussed under *Counter-irritants* in Part III.

Spanish fly is most frequently used in cerebral hyperæmia, being applied to the nape; in acute pleurisy, pericarditis, peritonitis, and meningitis—sometimes in the first stage, especially if pain be severe, but more frequently in the third stage, to promote absorption of effusions and exudations; in subacute or chronic inflammation of the viscera, such as pneumonia, when resolution is slow, or the disease threatens to become chronic; and in subacute or chronic inflammation of peripheral parts, such as the conjunctiva, joints, bones, etc. Neuralgia, if distinctly local in origin and due to congestion or inflammation of the nerves, is sometimes completely relieved by cantharides blisters; and the pains of acute rheumatism are undoubtedly dispelled by the same means, which is further believed by some physicians to cut short the whole rheumatic process. A blister on the epigastrium is a successful mode of treatment in some forms of gastric pain and vomiting.

In every instance, cantharis should be cautiously applied to children, to persons suffering from kidney disease, and to the aged and infirm. The back must not be blistered in bed-ridden persons, lest bed-sores be produced. Blisters must never be forgotten or left too long on the skin, otherwise ulceration may be set up, as well as the remote local effects of the drug to be presently described.

Internally.—Cantharis is an irritant to the mouth, throat, and stomach, and must be given well diluted and in small doses of the tincture only.

2. ACTION IN THE BLOOD, AND SPECIFIC ACTION AND USES.

Cantharidin enters the blood both from the blistered surface and the stomach. The active principle finds its way into all the organs, to which it clings rather tenaciously. In large doses it disturbs the heart, respiration, and nervous system, producing a rapid pulse, headache, sensory disturbances, mental confusion, and finally death by asphyxia. It is not used in this connection.

3. REMOTE LOCAL ACTION AND USES.

Cantharidin is slowly excreted by the kidneys, and appears in the urine, which conveys it to the bladder and genital organs. Here it sets up a second set of local effects similar to its immediate action. Small doses cause a sense of heat in the perineum, itching of the meatus, frequent desire to micturate, and some **diuresis**. Larger doses set up acute parenchymatous nephritis, with all its characteristic symptoms, including scanty bloody urine, or even suppression; the penis becomes swollen, and painful erections occur, so that the drug has been described as an aphrodisiac. In women, the uterus may become congested and menstruation may be brought on.

In certain ill-understood cases of kidney disease, cantharis has proved a useful diuretic and renal alterative; also in some instances of disease or disorder of the bladder, prostate, and urethra, including spermatorrhœa. It is too dangerous a drug to be generally used for this purpose. For the same reason care must be taken to prevent the absorption of cantharidin by the skin.

ANNELIDA.

Hirudo—THE LEECH. — 1, Sanguisuga medicinalis, the Speckled Leech; and, 2, Sanguisuga officinalis, the Green Leech. Collected chiefly in France, Spain, Italy, and Hungary.

Characters.—Body elongated, two or three inches long, tapering to each end, plano-convex, wrinkled transversely; back olive-green, with six rusty-red longitudinal stripes. 1, belly greenish-yellow spotted with black; 2, belly olive-green not spotted.

ACTION AND USES.

The leech is employed to **abstract blood**, each leech removing, directly and by subsequent hæmorrhage, an average of half an ounce of blood. Leeching is depletive, and to some extent counter-irritant in effect; and is employed in a variety of congestive or inflammatory affections, superficial and visceral, as well as in cardiac distension and distress.

SYNOPSIS OF VEGETABLE AND ANIMAL PRODUCTS CONTAINED IN THE BRITISH PHARMACOPŒIA.

LEAVES.

- Digitalis
- Stramonium
- Aconitum
- Conium
- Cajuput
- Uva Ursi
- Buchu
- Matica
- Ruta
- Senna
- Laurocerasus
- Belladonna
- Hyoscyamus
- Tabacum

SEEDS OF FRUIT.

- Nux Vomica
- Hordeum
- Linum Usitatissimum
- Myristica
- Ricinus Communis
- Cardamomum
- Stramonium
- Sinapis
- Gossypium
- Areca
- Amygdala
- Physostigma
- Colchicum
- Triticum Vulgare
- Croton Tiglium

FRUITS.

- Capsicum
- Oliva
- Coriandrum
- Cubeba
- Prunus
- Anethum
- Rosa Canina
- Ficus
- Ecbalium
- Fœniculum
- Limon
- Aurantium
- Anisum
- Sabadilla
- Hordeum Perlatum
- Tamarindus
- Bela
- Cassia Pulpa
- Conium
- Uvæ
- Colocynthis
- Kamala
- Rhamnus
- Morus
- Pimenta
- Piper

BERRIES.

- Piper
- Pimenta
- Kamala
- Rhamnus

ROOTS.

- Ipecacuanha
- Calumba
- Podophyllum
- Rheum
- Hemidesmus
- Serpentaria
- Gentiana
- Jalapa
- Valeriana
- Armoracia
- Krameria
- Arnica
- Pareira
- Senega
- Sumbul
- Taraxacum
- Sarsa
- Granatum
- Glycyrrhiza
- Belladonna
- Aconitum
- Veratrum Viride
- Zingiber
- Filix Mas
- Pyrethrum
- Sassafras
- Scammonia
- Scilla
- Colchicum

BARKS.

- Canella
- Cascarilla
- Cinnamomum
- Mezereum
- Cusparia
- Nectandra
- Cinchona
- Ulmus
- Larix
- Quercus
- Granati Radix

CONCRETE OIL.

- Camphora
- Theobroma
- Myristica

OIL FROM THE OLEO-RESIN.

- Cubeba
- Terebinthina

FLOWERS OR BUDS.

- Caryophyllum
- Santonica
- Papaver Rhœas
- Crocus
- Mentha Piperita
- Mentha Viridis
- Rosa Gallica
- Rosa Centifolia
- Sambucus Niger
- Anthemis
- Lavandula
- Aurantium

OIL FROM FRUIT OR SEED.

- Amygdala Amara
- Amygdala Dulcis
- Ricinus Communis
- Anethum
- Myristica
- Anisum
- Croton
- Juniperus
- Oliva
- Linum
- Carum
- Caryophyllum
- Coriandrum
- Limon
- Pimenta
- Cubeba
- Ruta

SYNOPSIS OF VEGETABLE AND ANIMAL PRODUCTS CONTAINED IN THE BRITISH PHARMACOPŒIA (*continued*).

Whole Plant.

Chirata
Dulcamara
Lactuca
Lobelia
Rosmarinus

Resins.

Podophyllum
Jalapa
Scammonia
Guaiacum
Mastiche
Pix Burgundica
Pix Liquida
Pinus (Resina)

Oils from Leaves, Flowers, or Herbs.

Cajuput
Lavandula
Mentha Piperita
Mentha Viridis
Rosmarinus
Ruta
Cinnamomum
Anthemis
Sabina

Lignum.

Quassia
Hæmatoxylum
Guaiacum
Pterocarpus

Oleo-Resins.

Terebinthina Canadensis
Copaiba
Elemi
Thus Americanum

Starch from Seed.

Amylum

Lichen.

Cetraria

Excrescence

Galla

Corms.

Colchicum
Scilla

Hair of Seed.

Gossypium

Balsams.

Peru
Tolu
Benzoinum
Styrax Præparatus

Alkaloids.

Aconitia
Atropia
Beberia
Morphia
Quinia
Strychnia
Veratria

Tops.

Sabina
Scoparium
Cannabis Indica
Dulcamara
Cusso
Lupulus

Gum Resins.

Cambogia
Scammonium
Ammoniacum
Assafœtida
Galbanum
Myrrha

Animal Products.

Adeps
Cantharis
Castoreum
Cera flava
Cera alba
Cetaceum
Coccus
Fel Bovinum
Hirudo
Lac
Mel
Ol. Morrhuæ
Moschus
Ovi Vitellus
Saccharum Lactis
Sevum
Pepsin

Juices.

Opium
Aloes
Kino
Lactucarium
Guttapercha
Morus
Rhamnus
Saccharum
Theriacum
Elaterium
Catechu Pallidum

Gums.

Tragacantha
Acacia

Concrete Exudation.

Manna

Capsule.

Papaver Somniferum

Fungi.

Ergota
Cerevisiæ Fermentum

NON-OFFICINAL DRUGS.

The following Non-Officinal Drugs are extensively used in Medicine.

NAME.	PART OF PLANT.	NAME.	PART OF PLANT.
Actæa Racemosa	Root.	Iris	Rhizome
Araroba	Powder.	Muscaria	Alkaloid
Caffein	Alkaloid	Picrotoxine	Active Principle
Coca	Leaves.		
Convallaria	Plant.	Quebracho	Bark
Coto	Bark.	Rhamnus Frangula	Bark
Duboisia	Plant.		
Eucalyptus	Leaves.	Rhamnus Purshiana	Bark
Euonymus	Bark.		
Gelsemium	Root.	Salix	Bark
Guarana	Powdered seeds.	Spigelia	Root.
Hamamelis	Bark.	Tormentilla	Root.

CLASSIFIED TABLES OF THE PHARMACEUTICAL PREPARATIONS OF THE BRITISH PHARMACOPŒIA.

Aquæ.—Anethi, Aurantii Floris, Camphoræ, Carui, Chloroformi, Cinnamomi, Destillata, Fœniculi, Laurocerasi, Menthæ Piperitæ et Viridis, Pimentæ, Rosæ, Sambuci.

Aceta.—Cantharidis, Scillæ.

Cataplasmata.—Carbonis, Conii, Fermenti, Lini, Sinapis, Sodæ Chloratæ.

Chartæ.—Epispastica, Sinapis.

Confectiones. — Opii, Piperis, Rosæ Caninæ et Gallicæ, Scammonii, Sennæ, Sulphuris, Terebinthinæ.

Decocta.—Aloes Compositum, Cetrariæ, Cinchonæ Flavæ, Granati Radicis, Hæmatoxyli, Hordei, Papaveris, Pareiræ, Quercus, Sarsæ, Sarsæ Compositum, Scoparii, Taraxaci, Ulmi.

Emplastra.—Ammoniaci cum Hydrargyro, Belladonnæ, Calefaciens, Cantharidis, Cerati Saponis, Ferri, Galbani, Hydrargyri, Opii, Picis, Plumbi, Plumbi Iodidi, Resinæ, Saponis.

Enemata.—Aloes, Assafœtidæ, Magnesiæ Sulphatis, Opii, Tabaci, Terebinthinæ.

Essentia.—Anisi, Menthæ Piperitæ.

Extracta:

1. **Acetic Extract.**—Colchici Aceticum.
2. **Alcoholic Extracts.**—Cannabis Indicæ, Physostigmatis, Nucis Vomicæ, Jalapæ, Rhei, Lupuli, Papaveris, Colocynthidis Compositum, Stramonii.

3. **Aqueous Extracts.**—Calumbæ, Gentianæ, Aloes Barbadensis et Socotrinæ, Pareiræ, Hæmatoxyli, Anthemidis, Glycyrrhizæ, Krameriæ, Quassiæ, Opii.
4. **Ethereal Extracts.**—Ergotæ Liquidum, Filicis Liquidum, Mezerei Æthereum, Stramonii.
5. **Fresh Extracts.**—Colchici, Colchici Aceticum, Taraxaci.
6. **Green Extracts.**—Aconiti, Belladonnæ, Conii, Hyoscyami, Lactucæ.
7. **Liquid Extracts.**—Ergotæ Liquidum, Belæ Liquidum, Pareiræ Liquidum, Sarsæ Liquidum, Cinchonæ Flavæ Liquidum, Opii Liquidum, Filicis Liquidum.

Glycerina. — Acidi Carbolici, Acidi Gallici, Acidi Tannici, Amyli, Boracis.

Infusa.—Anthemidis, Aurantii, Aurantii Compositum, Buchu, Calumbæ, Caryophylli, Cascarillæ, Catechu, Chiratæ, Cinchonæ Flavæ, Cuspariæ, Cusso, Digitalis, Dulcamaræ, Ergotæ, Gentianæ Compositum, Krameriæ, Lini, Lupuli, Maticæ, Quassiæ, Rhei, Rosæ Acidum, Senegæ, Sennæ, Serpentariæ Uvæ Ursi, Valerianæ.

Injectio.—Morphiæ Hypodermica.

Linimenta. –Aconiti, Ammoniæ, Belladonnæ, Calcis, Camphoræ, Camphoræ Compositum, Chloroformi, Crotonis, Hydrargyri, Iodi, Opii, Potassii Iodidi cum Sapone, Saponis, Sinapis Compositum, Terebinthinæ, Terebinthinæ Aceticum.

Liquores.—Ammoniæ, Ammoniæ Acetatis, Ammoniæ Citratis, Ammoniæ Fortior, Antimonii Chloridi, Arsenicalis, Arsenici Hydrochloricus, Atropiæ, Atropiæ Sulphatis, Bismuthi et Ammoniæ Citratis, Calcis, Calcis Chloratæ, Calcis Saccharatus, Chlori, Epispasticus, Ferri Perchloridi, Ferri Perchloridi Fortior, Ferri Pernitratis, Ferri Persulphatis, Guttæ Perchæ, Hydrargyri Nitratis Acidus, Hydrargyri Perchloridi, Iodi, Lithiæ Effervescens, Magnesiæ Carbonatis, Magnesiæ Citratis, Morphiæ Acetatis, Morphiæ Hydrochloratis, Plumbi Subacetatis, Plumbi Subacetatis Dilutus, Potassæ, Potassæ Effervescens, Potassæ Permanganatis, Sodæ, Sodæ Arseniatis, Sodæ Chloratæ, Sodæ Effervescens, Strychniæ, Zinci Chloridi.

Lotiones.—Hydrargyri Flava, Hydrargyri Nigra.

Mella.—Boracis, Depuratum, Oxymel.

Misturæ. — Ammoniaci, Amygdalæ, Creasoti, Cretæ, Ferri Aromatica, Ferri Composita, Gentianæ, Guaiaci, Scammonii, Sennæ Composita, Spiritus Vini Gallici.

Mucilagines.—Acaciæ, Amyli, Tragacanthæ.

Olea.—Amygdalæ, Anethi, Anisi, Anthemidis, Cajuputi, Carui, Caryophylli, Cinnamomi, Copaibæ, Coriandri, Crotonis, Cubebæ, Juniperi, Lavandulæ, Limonis, Lini, Menthæ Piperitæ et Viridis, Morrhuæ, Myristicæ, Myristicæ Expressum, Olivæ, Phosphoratum, Pimentæ, Ricini, Rosmarini, Rutæ, Sabinæ, Sinapis, Terebinthinæ, Theobromæ.

Pilulæ.—Aloes Barbadensis, Aloes et Assafœtidæ, Aloes et Ferri, Aloes et Myrrhæ, Aloes Socotrinæ, Assafœtidæ Composita, Cambogiæ Composita, Colocynthidis Composita, Conii Composita, Ferri Carbonatis, Ferri Iodidi, Hydrargyri, Hydrargyri Subchloridi Composita, Ipecacuanhæ cum Scillâ, Phosphori, Plumbi cum Opio, Quiniæ, Rhei Composita, Saponis Composita, Scammonii Composita, Scillæ Composita.

Pulveres.—Amygdalæ Compositus, Antimonialis, Catechu Compositus, Cinnamomi Compositus, Cretæ Aromaticus cum Opio, Glycyrrhizæ Compositus, Ipecacuanhæ Compositus, Jalapæ Compositus, Kino Compositus, Opii Compositus, Rhei Compositus, Scammonii Compositus, Tragacanthæ Compositus.

Spiritûs.—Ætheris, Ætheris Nitrosi, Ammoniæ Aromaticus, Ammoniæ Fœtidus, Armoraciæ Compositus, Cajuputi, Camphoræ, Chloroformi, Juniperi, Lavandulæ, Menthæ Piperitæ, Myristicæ, Rectificatus, Rosmarini, Tenuior, Vini Gallici.

Succi.—Belladonnæ, Conii, Hyoscyami, Scoparii, Taraxaci.

Suppositoria.—Acidi Carbolici cum Sapone, Acidi Tannici, Acidi Tannici cum Sapone, Hydrargyri, Morphiæ, Morphiæ cum Sapone, Plumbi Compositum.

Syrupi.—Simplex, Aurantii, Aurantii Floris, Chloral, Ferri Iodidi, Ferri Phosphatis, Hemidesmi, Limonis, Mori, Papaveris, Rhœados, Rhamni, Rhei, Rosæ Gallicæ, Scillæ, Tolutanus, Zingiberis.

Tincturæ.—*Those made with Rectified Spirit* are: Aconiti, Arnicæ, Assafœtidæ, Benzoini Composita, Cannabis Indicæ, Capsici, Castorei, Chloroformi Composita, Cubebæ, Ferri Acetatis et Perchloridi, Iodi, Kino, Lavandulæ Composita, Myrrhæ, Nucis Vomicæ, Opii Ammoniata, Pyrethri, Tolutana, Veratri Viridis, Zingiberis Fortior.

Those made with Proof Spirit are: Aloes, Aurantii, Belladonnæ, Buchu, Calumbæ, Camphoræ Composita, Cantharidis, Cardamomi Composita, Cascarillæ, Catechu, Chiratæ, Cinchonæ Composita et Flavæ, Cinnamomi, Cocci, Colchici Seminum, Conii Fructûs, Croci, Digitalis, Ergotæ, Gallæ, Gentianæ Composita Hyoscyami, Jalapæ, Krameriæ, Limonis, Lobeliæ, Lupuli, Opii, Quassiæ, Quiniæ Ammoniata, Rhei, Sabinæ, Scillæ, Senegæ, Sennæ, Serpentariæ, Stramonii, Sumbul, Valerianæ.

Those made with Aromatic Spirit of Ammonia, or Ammonia, are: Guaiaci Ammoniata, Valerianæ Ammoniata, Opii Ammoniata.

One in which Ether is used: Lobeliæ Æthereæ.

One in which Tincture of Orange is used: Quiniæ.

Trochisci.—Acidi Tannici, Bismuthi, Catechu, Ferri Redacti, Ipecacuanhæ, Morphiæ, Morphiæ et Ipecacuanhæ, Opii, Potassæ Chloratis, Sodæ Bicarbonatis.

Unguenta.—Aconitiæ, Antimonii Tartarati, Atropiæ, Belladonnæ, Cadmii Iodidi, Cantharidis, Cetacei, Creasoti, Elemi, Gallæ, Gallæ cum Opio, Hydrargyri, Hydrargyri Ammoniati, Hydrargyri Compositum, Hydrargyri Iodidi Rubri, Hydrargyri Nitratis, Hydrargyri Oxidi Rubri, Hydrargyri Subchloridi, Iodi, Picis Liquidæ, Plumbi Acetatis, Plumbi Carbonatis, Plumbi Iodidi, Plumbi Subacetatis Compositum, Potassæ Sulphuratæ, Potassii Iodidi, Resinæ, Sabinæ, Simplex, Sulphuris, Sulphuris Iodidi, Terebinthinæ, Veratriæ, Zinci.

Vapores.—Acidi Hydrocyanici, Chlori, Coniæ, Creasoti, Iodi.

Vina.—Aloes, Antimoniale, Aurantii, Colchici, Ferri, Ferri Citratis, Ipecacuanhæ, Opii, Quiniæ, Rhei, Xericum.

Part III.

GENERAL THERAPEUTICS.

CHAPTER I.

INTRODUCTION: THE FOUNDATIONS OF RATIONAL TREATMENT.

THE terms THERAPEUTICS and TREATMENT, although they may at first sight appear too simple to call for analysis, are found, on careful consideration, to include four different notions. These we must study individually.

1. **Health.**—The first notion involved in Treatment is a purely *physiological* one, the conception of *health*, or the normal state, from which the organ has departed, and to which it has to be restored. Health is the result of a number of natural influences acting on the individual, namely, the *extrinsic* circumstances around him, and the *intrinsic* conditions which he brought into the world with him. Our organs having reached their present state by a process of evolution under the influence of the various natural forces which surround us, are obedient to these influences; and when a definite change is thus produced upon them, we call it the "physiological action" of the influence. The first point for the therapeutist to appreciate is, that just as the forces which surround us are themselves constantly varying—the various conditions of the temperature, the air, our food, in short our whole environment, being inconstant—so the physiological state of the body is not a constant quantity. We speak of a "normal" state, and call it "health," but the first essential of life and health is power of change and accommodation to varying circumstances.

2. **Pharmacodynamics: Physiological action.**—The second elementary notion in the expression "treatment" is, that we possess a certain power of interference, a control over the conditions and circumstances of life, and thus a certain control over the health or physiological state of the individual. A very little consideration will enable us to appreciate our power over the forces of nature. Most of the influences we have just considered as normal in their effects, and many that are entirely morbid in character, are within our control. We can alter the food we eat, the air we breathe,

our clothing, our sources of heat; we may admit into our bodies substances which we find in nature—mineral, vegetable, animal, or altogether artificial. On the other hand, we may voluntarily shun or reject such substances, and avoid many influences, whether for good or for bad, around us. To express this control which we have over our organs and functions, through the conditions to which we can voluntarily subject them, we say we *act physiologically upon them* by such and such means, or that such and such a substance has such and such a *physiological action;* and the science that relates to this power which we possess of modifying physiological activity we call *Pharmacodynamics.*

3. **Pathology.**—The conception of *disease* is also included in "treatment." When the conditions which surround us become unusual or extraordinary, they lead to disturbance of the vital processes. If this be moderate, it is still included under the name of "health;" but if considerable, it is called *disorder* or *disease*, and the influence is called a *morbid* influence. It is essentially impossible to draw a line between health and disease, just as it is impossible to divide influences into salutary or physiological, and morbid or pathological. The pulse is accelerated by joy, by wine, by fever; which of these conditions is health, which disease? All that can be said is, that the change from the normal state is frequently so definite that we cannot reasonably call it "health," that we must find another name for it, and call it "disorder;" or if it be more marked, and attended by suffering, "disease."

4. **Recovery.**—Successful treatment necessarily involves a *power of recovery*. The body possesses abundant provisions for preventing disease, and of recovering from its effects. This power of meeting and overcoming morbid influences depends essentially on the great physiological law which we have already noticed, that the activity of the tissues and organs is not fixed and constant, but varies (within certain limits) with the conditions to which it is subjected. The body is abundantly provided with the following means by which this variation of functional activity can be secured:

First, when occasion demands it, the organs can display an *extraordinary amount of force*, as we see in the case of a muscle such as the biceps, or the heart. The organs thus possess a certain amount of *reserve force*, which is frequently called into play as a means of preventing disease. But for this, we should break down in every part of our body as often as we made an extra demand upon it.

Secondly, if this reserve force be constantly called into play by the continuance of some extraordinary cause, the increased activity gives rise to enlargement or hypertrophy of the organ, and what is known as *compensation* is the result. This great natural method of prevention or recovery by *overcoming the cause of disorder* is well seen in heart disease, and in enlargement of one kidney when the other is diseased.

Instead of themselves meeting extraordinary circumstances by extraordinary activity, many organs are provided with *regulating mechanisms*, by which they can throw them off or escape from them, that is, *expel the cause of disorder.* The stomach rejects a heavy or improper meal; the heart can, to some extent, relieve itself of excessive peripheral resistance in systole, through the depressor mechanism; and the body heat is elaborately regulated by various nervous arrangements.

Thirdly, the work of one organ may sometimes be undertaken by another organ, which thus *removes the effects* of the disorder. This is called *vicarious compensation*, and is well seen at work between the kidney and other excretory organs.

Fourthly, even when disease and anatomical change have actually occurred, the body possesses means of recovery of the nature of *repair*, which is associated with nutritive activity and frequently with the inflammatory process.

These considerations teach us that just as our organs and functions continue normal, like everything else in nature, in obedience to the laws under which they have reached their present form, so, if they have become deranged by unusual influences, they will return to the normal when such abnormal influences have been overcome or removed.

5. **Therapeutics.**—The following are the four foundations of rational therapeutics. (1) Inasmuch as the organs act in obedience to natural forces in and around us; (2) since we possess the power of controlling these forces; (3) since disorder and disease are but the physiological phenomena, or the anatomical results of the disturbing action of ordinary or extraordinary influences; and (4) since the functions of the organs, and, it may be, even their anatomical state will return to the normal, if the influences become normal: it logically follows that therapeutics as a science consists in bending to our will the numerous natural forces which affect the human body, or in counteracting or neutralising their effects by other forces, until, in either case nature returns to the normal. To handle, as it were, the natural influences which surround us in such a manner as to effect this change on the functions of the body, is called *treating the disorders or diseases* of it. It is with this meaning that we shall speak of *rational treatment*.

Now it is evident that treatment may be of many kinds:

1. **Preventive treatment.**—The science and art of preserving health is known as *Hygiene*, and it is manifestly founded on an accurate knowledge of physiology. If we thoroughly understood physiology, and had unlimited power over the forces of nature, we might so preserve health that disease would be unknown. Unfortunately, we have neither this knowledge nor this power except in a small measure, and hygiene is correspondingly imperfect; but as far as it goes, hygiene renders therapeutics unnecessary.

Another form of preventive treatment is *prophylaxis.* This is something more than simple hygiene or preservation of health; it recognises the causes of disease at work, and either avoids them or counteracts them by anticipation.

Prophylactic treatment may be either *negative* or *positive:* a man may guard against infection by avoiding certain things, such as water which is poisoned by cholera or typhoid fever; or he may have himself vaccinated to prevent small-pox, take quinia to prevent ague, or drink lemon-juice to prevent scurvy.

2. **Immediate treatment.**—When hygiene and prophylaxis are powerless or cannot be employed, the case comes into the hands of the therapeutist. The organism is disturbed, deranged, or diseased, and now there is an occasion for *therapeutics*, for *remedy*, for *relief*, or for *cure*. All these terms manifestly imply a necessity for interference, that is, the actual presence of derangement from the normal state, and they introduce us to our own proper subject.

a. Removal of the cause.—Having met with a case of disease which we have failed to prevent, we first naturally try to *remove or destroy the cause*, and thus restore the normal state We extract a foreign body from the finger, or a poison or indigestible meal from the stomach; we neutralise an acid by an alkali; we kill parasites. In doing so, we simply follow nature's second method of recovery. Now there are manifestly as many ways of effecting a cure as there are causes of disease. We may alter the food, and then we say the treatment is **dietetic**; we may alter the atmosphere, and then we say the treatment is **climatic**; or we may employ the chemical and other substances contained in the Pharmacopœia, when our treatment will become **medicinal.**

b. Symptomatic treatment.—If we fail to remove the morbid influence, we may attempt to *neutralise or counteract its morbid effects* on the body. Knowing the physiological action of many different measures, we select such as act in an opposite direction to the morbid cause, and employ them to counteract it. As a method of treatment this is manifestly much inferior to the preceding; we are now striking not at the cause of disease, but only at its effects. Still even this limited power may be of the greatest value; sometimes it is all that is required—we may have to treat only the effect that persists after the cause has ceased or been removed, especially in sensitive and vital organs. This kind of treatment is called **symptomatic, palliative,** and under certain circumstances **expectant** (*expectare*, to wait); it is manifestly a copy of the third method of natural recovery.

It is evident that we have before us here an enormous field for research and application. If we can but find a means, whether medicinal or not, which shall counteract each abnormal condition to which the body may be subjected, we may defy disease. But here we are met by certain difficulties. Before we can hope to combat disease in this way, we must know (1) all about disease and its causes, that is, we must have a perfect pathology; and (2) all about the effects of therapeutical agents upon the body, that is, have a complete pharmacodynamics or pharmacology. It is unnecessary to say how far either the one or the other of these is from being a complete science. Another discouraging fact is that there is a *limit* to all hope of a cure, a limit to all treatment, because the morbid influence may have so far anticipated the remedial as to have altered the body structurally. If a limb is lost, we cannot restore it; if the mitral valve is covered with diseased growth, we cannot renovate it. But we are right when we maintain that these organic structural changes, grave or hopeless as they may be, are but the results of the action of some cause with simple beginnings, which we shall yet discover. As our knowledge of pathology advances we are steadily learning, *e.g.* more about the nature and origin of cancer, for which the limb had to be removed; more about the causes of rheumatism, which covered the cardiac valve with unnatural growth. If we ever cure cancer and rheumatism, we shall manifestly do so by influencing the causes or the beginnings of the two diseases: medicines may be expected to affect morbid *processes* rather than *products*, to alter morbid physiology rather than morbid anatomy. We do, however, possess certain means of treating even structural changes of organs, as we shall discover when we come to discuss metabolism.

The student is now in a position to consider the meaning of two terms constantly being employed in therapeutics—namely, **rational treatment** and **empirical treatment.** Treatment is said to be *rational* when it is suggested by all our chemical, physiological, and pathological knowledge. Such treatment must be successful if our observations are correct: it is founded on great natural laws which are known and understood. *Empirical* treatment is founded on experience only, and conforms to no yet known law. It may be, and frequently is, as successful as rational treatment, or sometimes even more so; but whether successful or unsuccessful, we can offer no scientific reason for it. All that we can say is, that experience has proved incontestably that a particular kind of treatment was beneficial in a multitude of instances, and that it will probably be beneficial again. We hope soon to know more about the various remedies that have been successfully employed ; and as we acquire this knowledge, and come to be able to give a reason for their effects, *i.e.* refer them to some great natural law, we shall transfer these remedies from the group headed "empirical," and add them to the group called "rational." Therapeutics will become a perfect science when empiricism has thus without exception given place to rationalism.

Plan of the following chapters.—In approaching the study of the general therapeutics of the different systems of the body, we will adopt the following plan suggested by the preceding considerations: (1) We shall give a brief sketch of the *physiological* relations of the system. (2) We shall consider fully the *pharmacodynamics* of the same, dealing chiefly with the drugs examined in the previous parts of the work, but referring frequently to non-medicinal measures, such as food, air, exercise, and baths. (3) A rapid sketch will be given of some of the *pathological* relations of the system, those being selected which best serve to illustrate the action and uses of remedies, *i.e.* disorders or derangements rather than diseases of the parts. (4) A brief reference will be made to the evidence of *natural recovery* in the particular system, and to the failure of such attempts, *i.e.* the *limits of treatment.* (5) The *rational therapeutics* of the system, founded on the previous four divisions, will complete the account.

CHAPTER II.

DIGESTION.—THE MOUTH.

I. PHYSIOLOGICAL RELATIONS.

THE process of digestion begins with the reception of food, more or less prepared by cooking. During its brief stay in the mouth, the food is triturated and mixed with mucus and saliva, and its starchy constituents are partly converted into sugar.

1. *Food* forms no part of the subject of the present work, and it will be sufficient to remind the student that the chief proximate principles of a proper diet are proteids, amyloids, fat,

salts, and water. The relative proportions of these constituents vary greatly in different kinds of food.

2. The *sensory nerves* of the mouth (the glosso-pharyngeal, and the lingual and other branches of the trigeminus) receive and transmit to the cerebrum and medulla the impressions of taste, as they are commonly called, whether sweet (the pleasant taste referable to amylolytic action), bitter, salt, sour, hot, burning, warm, pungent, acrid, or nauseous; and the many kinds of aromatic flavours, which are chiefly, however, odours. In the medulla the gustatory impressions fall into a special centre, whence they are reflected (1) to the stomach, the functions of which they modify, as we shall see; and (2) to the salivary and mucous glands of the mouth, which they also influence, chiefly through the chorda tympani. Through the same efferent nerve come other impulses: from the cerebrum, as the result of the sight, taste, smell, or even idea of food; from the stomach, conveyed by the vagus; and, doubtless, from many other sensitive parts, especially in the abdomen.

3. The *flow of saliva and mucus* is the result of the nervous impulses which have just been traced, and which stimulate the protoplasm of the epithelial cells, and actively dilate the vessels. The saliva is secreted at the commencement of digestion, is intimately mixed with the food, and imparts to the bolus a faintly alkaline reaction which has an important effect on secretion in the stomach.

4. It is well to distinguish from the ordinary secretions of the mouth, the *excretions* which are also thrown out by the glands. Although these are but little appreciated in health, they are familiar as the source of certain unpleasant tastes in the mouth and odours of the breath, after particular kinds of food and drink, such as wines, and many drugs.

5. The *muscular acts* of mastication and swallowing are guided by the afferent impressions and by the will.

II. PHARMACODYNAMICS.

We come now to inquire, according to the plan which we have sketched, whether we possess any means of influencing the normal functions of the mouth, and if so, how far such powers can be usefully applied.

1. *Food.*—We have absolute control over our food. We can withhold it altogether; we can alter its quantity and its quality as we please. Especially as regards the mouth, we may modify the proportion of amyloids in the diet, affect their condition by cookery, or convert them wholly or partially into sugar before administration. Malt extracts consist chiefly of dextrin and maltose, made from malted grain and flour.

The control which we thus possess over food is the foundation of the vast subject of dietetics.

2. The *sensory apparatus* in the mouth can be variously influenced. The variety of natural tastes and flavours of which we may avail ourselves is endless; artificial products are hardly less numerous. The art of cookery is much concerned with the proper use of these; so is the growth of wines; and the many natural and artificial condiments act chiefly upon the palate, such as mustard, pickles, and sauces. Beyond the culinary art, an immense number of medicinal agents are contained in the materia medica which may be used in therapeutics proper, to act upon the tongue and palate, and thus upon the nervous centres and viscera. These may be arranged as follows: (1) The great group of warm **aromatic** oils, including Cloves, Allspice, Peppermint, Rosemary, Lavender, Nutmeg, and many others, each with its own peculiar flavour; (2) **bitters**, such as Calumba, Quassia, Quinia, etc.; (3) **aromatic bitters**, of which Gentian, Orange, and Cascarilla are examples; (4) the **spirituous** group, including Spirits, Wines, Chloroform, and Ether; (5) **pungent** substances proper, such as Mustard, Horseradish, and Pyrethrum; (6) **sweet** substances, including Sugar, Liquorice, Glycerine, etc.; and (7) **acid or sour** substances, such as the Mineral Acids, Acid Fruits, and Acid Tartrate of Potash, to which we shall presently return.

The value of aromatics, bitters, and the other stimulants of the nerves of the mouth, lies in the fact that whilst they increase relish or the enjoyment of eating, and thus the appetite and the amount of food consumed, they provide for the digestion of this increased quantity of nourishment by stimulating the secretion of the digestive fluids in the mouth, and, as we shall see in the next section, in the stomach also.

The effect of these substances on the palate also affords us means of covering the tastes of nauseous medicines, of which we constantly avail ourselves. On the other hand, we may employ the unpleasant taste or flavour of certain drugs, such as Valerian and Assafœtida, to produce through the afferent nerves a powerful influence on the sensorium which we may sometimes have occasion to employ.

3. *Salivary and mucous glands.*—Substances and measures which increase the flow of saliva are called **sialagogues** (*σίαλον*, saliva, and *ἄγειν*, to cause to flow), and include the greater number of the stimulants of the sensory apparatus just classified. Of these the most important sialagogues are unquestionably diluted acids, including the Diluted Mineral Acids,

Carbonic Acid in effervescence, Vegetable Acids and their salts, wines (which are all acid to a degree), and acid fruits and juices, of which Lemon may serve as a type. The familiar effect of acid drinks in relieving thirst cannot, however, be entirely explained by their influence on the nerves of taste. Here the student is introduced to a great physiological law, which we shall frequently have occasion to notice, *that acid substances stimulate alkaline secretions, and alkaline substances stimulate acid secretions.* The action is probably a local one, the acid or alkali, as the case may be, being quickly absorbed, and reaching the protoplasm of the glands direct.

Other drugs act as *specific sialagogues* upon the terminations of the portio dura in the salivary glands, or on the cells themselves. Such are Jaborandi, and its active principle Pilocarpin, Tobacco, Physostigma, Mercury and Iodine, and the indirect emetics Antimony and Ipecacuanha.

Opposed to these measures are the **antisialagogues,** equally at our service, although but rarely employed. Such are *insipid or nauseous* articles of food or medicine, with which may be classed *depressing emotions and other nervous influences ;* dilute *alkaline* or soapy substances acting locally, such as Potash, Soda, and Lime ; and certain articles of the first importance in the materia medica which act upon the secreting nerves, and may, therefore, be called *specific antisialagogues.* The type of these is Belladonna (Atropia), with Hyoscyamus, and Stramonium (Hyoscyamia). Tobacco in excess has the same effect, as well as Opium.

If the natural secretion fail, certain *substitutes* for the mucus may be employed, which are called **demulcents** (*demulcere*, to soothe), as they sheathe the mouth, tongue, and fauces with a protective coating. Such are simple drinks, especially tepid water, toast-water, water and milk ; mucilaginous preparations, in a fluid or solid form, including barley-water, gruel, and linseed tea ; various preparations of gelatine and isinglass ; lozenges made with gums ; preparations of starch, eggs, honey, figs, and bread ; palatable oils ; syrups ; and ice.

4. The *excretions* of the mouth can also be influenced by means of substances which are thrown out of the system by this channel, such as Iodine, Lead, and Mercury. The therapeutist can hardly be said to avail himself of this means of acting on the mouth.

5. The *mastication and insalivation* of the food can also be regulated, on the one hand by insuring time and care in the process of eating, and on the other hand by ordering such a diet as is entirely fluid, or may be thoroughly triturated and exposed to the juices of the mouth.

III. PATHOLOGICAL RELATIONS.

As has been already suggested, the pathological relations of the mouth and the first part of the digestive process, are of less interest in themselves, for our present purpose, than from their bearing upon digestion in the stomach, and the farther progress of the food.

1. We discover in the *food* the chief cause of all digestive disorders, whether it be unsuitable in quality, excessive in quantity, or taken at over frequent or irregular times.

2. Loss of the *sense of taste* is familiar in fever, the result being further arrest of the salivary flow, and interference with relish and appetite, always a serious matter in such cases. In this connection must be mentioned the unfortunate tastes of most drugs, the difficulty of their administration, and the degree to which they interfere with the appetite.

3. Disorders of the *secretions* of the mouth include chiefly disturbances of the quantity of saliva and mucus. The saliva is probably deficient in some cases of long standing indigestion; and it is markedly wanting in acute febrile conditions, causing dryness of the tongue and mouth, thirst, loss of relish as we have just seen, and inability to swallow, the morsel being rolled hopelessly about the mouth. A somewhat similar condition may be induced by depressing emotions, such as fear or grief; or by certain medicinal or dietetic substances, including Belladonna, Opium, and Alcohol. Excessive secretion of saliva and mucus ("salivation") was very frequent in the days when Mercury was regularly administered until the "gums were touched"; and is still occasionally seen from the same cause, as the result chiefly of accident or idiosyncrasy; or as the effect of Iodine and Iodide of Potassium, under similar circumstances. A *reflex* salivary flow of a very interesting kind occurs at the commencement of vomiting, and in some cases of gastro-intestinal disorder, constituting one form of "pyrosis" or "water-brash." In other cases salivation is produced by disease of the nervous centres.

4. Derangements of the *excretions* of the mouth are among the causes of the "bad taste" and unpleasant odour of the breath, connected with digestive derangements; the other principal causes of the same being decomposition in the mouth, or excretion by the respiratory passages. Some drugs already mentioned have the same effect, such as Mercury, Iodine, Bromine, and Lead; and the prevention of this unpleasant action may be a difficult task.

5. Second only to the food itself as a frequent cause of indigestion is the imperfect manner in which the *mechanical*

processes in the mouth are performed, the solids being imperfectly masticated and insufficiently insalivated from hasty or careless eating, or from disease or actual loss of the teeth.

IV. NATURAL RECOVERY.

We have next to enquire, whether natural recovery, as defined by us in the first chapter, ever occurs in connection with the mouth and its functions. Observation places this beyond doubt, in all the classes of disorder to which we have just referred. The sense of taste is restored after fever has gone. The secretions which have been deranged by the same cause, or by Atropia, Mercury, or Jaborandi, return to the normal quantity and quality when the disturbing influence is spent or has been removed. The excretions again become "sweet" when the substance that disordered them has been completely thrown out. The teeth present side by side with decay a process of repair, which frequently counteracts it.

There is, however, a *limit* to recovery in the mouth, as elsewhere. The teeth decay and fall out; and the other tissues may become involved in serious or hopeless disease. Even then, as we shall presently see, rational treatment is not impossible.

V. THERAPEUTICS.

The rational treatment of diseases originating in the mouth is but the scientific application of the knowledge arranged under the previous four heads, respecting its physiology, the forces acting on the mouth which are at our command, the causes and phenomena of its derangements, and the occurrence and limits of natural recovery.

1. The *food* must always receive most careful supervision, not only in cases where it has been bad, improperly taken, or imperfectly masticated, but in every instance of disorder of digestion from whatever cause, in the mouth or other part of the alimentary canal. The details of dietetic treatment must be learned from other works.

2. The disorders of the *sensory apparatus* of the mouth very rarely call for treatment, but we have constant occasion to avail ourselves of our influence over the nerves of taste for the purpose of relieving derangements of the *secretions*. Thus deficiency of saliva, and the distressing thirst and loss of relish which attend it in fever, may be relieved either through the nerves of taste, or more directly by means of acids in the form of drinks, such as water acidulated with the Mineral Acids, Vinegar and water, Carbonic Acid in effervescing drinks, Cream of Tartar, Lemon Juice in various combinations, and acid fruits,

if not otherwise unsafe, including the Tamarind of the pharmacopœia, grapes, and oranges. Failing or instead of these, ice, sips of water, and some of the demulcents already enumerated may be given. When the deficiency of saliva, the dryness of the mouth, and the lack of relish are less urgent but more persistent, as in chronic dyspepsia, we adopt more pleasing means of stimulation. We have recourse to aromatic, bitter, spirituous, and pungent articles. We order food specially flavoured or made otherwise agreeable to the palate by artistic cookery. When the appetite flags after severe illness or in exhaustion from other causes, we recommend the patient to stimulate his palate with a little wholesome wine, which is at once acid, aromatic, and spirituous. We rouse the nerves of taste and the secreting glands by simple or aromatic bitters in acid or alcoholic combinations before or during meals, or pungent and acid condiments, such as mustard, pepper, and pickles.

3. When it is desired to rouse the gustatory and secreting functions of the mouth independently of digestion, *e.g.* in cases of paralysis of the mouth, and in the chronic thirst of Bright's disease and diabetes, such substances as Pyrethrum, Tobacco, and small doses of Pilocarpin are indicated. The dryness of the mouth and throat caused by Atropia and Hyoscyamia may require the suspension of the drug, or Jaborandi may be prescribed with it unless contra-indicated. On the other hand, salivation produced by drugs must be arrested by removal of the cause, such as Mercury, or the exhibition of Belladonna.

4. The treatment of unpleasant *excretions* from the mouth is rationally carried out by removing their cause, especially disorder of the stomach and bowels; deodorising the breath; or imparting to it an artificial odour.

5. Defects in the *mechanical apparatus* of the mouth, especially the teeth, have, as a rule, advanced beyond the limits of functional treatment. Even then treatment is not only possible, but dental surgery is one of the most rational and successful branches of local therapeutics. Short of this, much can be done by ordering food in a soft or fluid form, and directing that time and care be spent by the patient over the process of masticating, tasting, and insalivating every morsel.

Lastly, a discussion of the action of drugs upon the mouth introduces us naturally to the therapeutics of the next stage of the digestive process—in the stomach. The substances which stimulate the nerves of taste are constantly employed, as we shall see, to produce reflex activity of the gastric functions; and the thorough insalivation with the alkaline juices of the mouth, for which they also provide, may be used as a powerful means of increasing the acid secretion.

SYNOPSIS OF REMEDIES WHICH ACT UPON THE MOUTH.

BITTERS.	AROMATICS.	AROMATIC BITTERS.	SWEETS.	ACID SUBSTANCES.	DEMULCENTS.	SIALAGOGUES.	ANTI-SIALAGOGUE.
Rheum	Rosmarinum	Cascarilla	Glycyrrhiza	Pot. Tartr. Acida	Ficus	Tabacum	Potassium
Nectandra and Beberia	Mentha Piperita	Anthemis	Glycerinum	Tamarindus	Ulmus	Jaborandi	Soda
Aloe	Mentha Viridis	Gentiana	Saccharum	Limon	Egg	Physostigma	Ammonia
Cinchona and Quinia	Cinnamomum	Chiretta	Theriaca	Aurantium	Hordeum	Acids	Calcium
Taraxacum	Lavandula	Lupulus	Mel	Wines	Tamarindus	Potassæ Tartras Acida	Lithia
Nux Vomica and Strychnia	Eucalyptus	Serpentaria	Tamarindus	Acidum Sulphuricum Dilutum	Linum	Tamarindus	Magnesium
Calumba	Sambucus	Limon	Chloroformum	Acidum Nitricum Dilutum	Uvæ	Limon	Opium
Quassia	Rosæ	Aurantium		Acidum Hydrochloricum Dilutum	Tragacantha	Aurantium	Belladonna
	Zingiber	Canella		Acidum Nitro-Hydrochloricum Dilutum	Acacia	Prunus	Hyoscyamus
	Cardamomum	Cusparia		Acidum Aceticum Dilutum	Amygdala	Wines	Stramonium
	Myristica			Acetum	Cassia	Hydrargyrum	Nauseous substances
	Caryophyllum			Oxymel	Water	Ioda	Insipid foods and drinks
	Oleum Cajuputi		**PUNGENTS OR ACRID.**	Acidum Phosphoricum Dilutum	Ice	Antimonium	Tabacum (excess)
	Carui			Acid Tartaricum	Milk	Ipecacuanha	
	Fœniculum			Ac. Citricum	Isinglass		
	Oleum Anisi	**SPIRITUOUS.**	Piper (partly aromatic)	Ac. Carbonicum	Cetraria		
	Anethum		Cubeba ditto		Syrupus		
	Coriandrum		Pyrethrum		Theriaca		
		Alcohol (in every form)	Capsicum		Mel		
	Ammoniacum	Æther	Sinapis		Amylum		
	Assafœtida	Chloroformum	Armoracia		Triticum		
	Castor		Guaiacum		Oleum Olivæ		
	Valeriana				Oleum Amygdalæ		
	Moschus						
	Sumbul						

CHAPTER III.

DIGESTION.—THE STOMACH.

I. PHYSIOLOGICAL RELATIONS.

GASTRIC digestion is mainly effected by the gastric juice, an acid secretion which owes its solvent and chemical power to pepsin and hydrochloric acid. The gastric secretion is stimulated by the *mechanical* presence of food; by the *products* of digestion, part of which is rapidly absorbed; by impressions on the *nervous centres*, such as tastes, which were referred to in the previous chapter; and by the presence of saliva and other *dilute alkaline fluids* at the mouths of the tubules. During digestion the gastric vessels actively dilate; the muscles move vigorously; by the end of four hours much of the proteids have become peptones; the sugar, starch, and fats are broken down or emulsified, but remain chemically unaltered; and the whole of the products, constituting the chyme, are transferred to the duodenum.

The nervous arrangement by which the stomach is stimulated, or prepared to receive and digest food, is chiefly a local one; the contact of food, digested products, and dilute alkalies acting on ganglia in the gastric wall itself. Besides this, the stomach is connected with a *centre* in the medulla, and with the cerebrum, by means of afferent and efferent nerves—the vagus and the sympathetic. The impressions which thus reach the sensorium and the gastric centre are reflected as *impulses* to the stomach, through the efferent nerves; which also convey from the cerebrum the impulses generated by sensations of taste, as we saw in the last chapter, as well as by the smell, sight, or idea of food. Besides these, numerous impressions from the intestines, liver, kidneys, and generative organs, indeed from all impressionable parts whatsoever, influence the stomach by being reflected to it through its centre in the medulla. The influence of these nervous impulses upon the stomach is very marked. They affect the secreting glands, the vessels, and the muscles, exciting, arresting, or otherwise modifying, as the case may be, the secretion of gastric juice; and under certain circumstances they give rise to vomiting.

II. PHARMACODYNAMICS.

We have now to inquire how many of the conditions which influence gastric digestion are under our control: how far we can act physiologically on the stomach.

1. We have complete power over all that enters the stomach in the form of *food* and drink, and much influence, as we have seen, over salivary digestion. Even if the food have left the mouth and reached the stomach, we can evacuate its contents by means of the pump, or by the use of emetics, which will be considered in chapter iv.

2. As regards the *gastric juice*, we can increase its flow in many ways. We can irritate the tubules mechanically by the character of the food, making it more or less solid as may be required. We may provide, as the first part of the meal, substances, such as soup, which will be rapidly peptonised and absorbed, and stimulate the follicles to abundant secretion. We can subject the secretion to nervous influences which are at our command, such as the agreeable sensations of taste, which are aroused by artistic cookery, wholesome condiments, and grateful wines, as well as by pleasing associations during meals. The activity of the glands may be increased through the medium of the local circulation by various means to be presently described. Further, we can provide for moderate alkalinity of the contents of the stomach, by increasing the salivary flow. The same end may be secured more certainly by the administration of dilute alkaline solutions before meals, such as Bicarbonate of Soda, Sal-volatile, or Liquor Potassæ, which are amongst the most useful and generally employed of remedies, and constitute the **alkaline stomachics.** We can go even farther than this, and modify the amount either of the pepsin, or of the hydrochloric acid, or of both, by giving them along with the food, and thus constituting them **digestive adjuvants.**

3. The activity of the *nerves* of the stomach is readily influenced in either direction. We may increase their sensibility by administering the same series of hot substances which we studied in the mouth, such as Alcohol, Aromatic Oils, Pepper, and Mustard; the effect being not confined to a sense of warmth in the epigastrium, but extending to stimulation of the local, and even the general circulation, and the associated nervous structures, as we shall presently see. These substances, as well as the aromatic bitters, such as Gentian or Orange, and the simple bitters, such as Calumba, have the effect of stimulating the nerves, dilating the vessels, and possibly increasing the activity of the glands and muscles of the stomach, whilst they create the sensation of hunger, probably by setting up these changes in the gastric wall. They form, therefore, other groups of stomachics, **the aromatic, spirituous, bitter** and **pungent stomachics.** On the contrary, we may appease the sense of hunger by such artificial means as tobacco smoking.

Equally powerful is the influence of many substances and measures, as **gastric sedatives,** in reducing the sensibility of the afferent nerves, and thus interfering with gastric sensations, and the gastric functions which depend upon the reflection of impressions. Opium is thus all-powerful in preventing or relieving pain in the stomach, and in arresting the gastric secretions and movements. Diluted Hydrocyanic Acid and Belladonna and its allies, also act in this way; as well as Carbonic Acid in the form of effervescence; and water, either as hot as it can be drunk or in the form of ice. Bismuth, whether considered mechanically or physiologically is uncertain; and Oxalate of Cerium is in a manner still obscure. A number of drugs remove causes of irritation, and are thus gastric sedatives, such as Oxide of Silver, Creasote, and Carbolic Acid, which arrest disorder of the mucous membrane. Various applications to the epigastrium, including poultices, fomentations, and blisters, afford a convenient means of soothing the gastric nerves reflexly through the nervous centres.

4. The *circulation* in the stomach is also so far under our control, as we have already seen. The many substances which stimulate the nerves also redden the surface of the mucous membrane, by dilating the vessels and increasing the local blood flow within physiological limits, such as Alcohol, Ether, Aromatic and Pungent articles (Pepper, Mustard, Capsicum, etc.), and Bitters. Besides these, there are numerous substances of a more powerfully irritant nature which we note chiefly for the purpose of suggesting caution in their employment for other purposes. Arsenic, Iron, Mercury, and indeed the salts of most of the metals: Senega, Digitalis, and Scilla; Colchicum and Veratria, are examples of drugs which are specially apt to derange digestion. On the other hand, the local circulation can be rendered less active by means of Acids; salts of Silver, Zinc, Lead, in small doses; Ergot, Opium, Tannic Acid, and the many vegetable astringents containing it, such as Kino, Catechu, and Cinnamon. These are **gastric astringents,** and indirectly, therefore, another class of *gastric sedatives.*

5. The *movements* of the stomach can be readily modified. The energy of the churning movements increases with the acidity of the chyme, and we can take advantage of this knowledge by administering acids after meals, such as Diluted Nitric, Hydrochloric, or Nitrohydrochloric Acids, which are thus another class of *gastric stimulants*, sometimes called **gastric or stomachic tonics.** Specific nervo-muscular stimulants, such as Strychnia, probably act in the same way, as well as the stimulants of the nerves and vessels, especially Ether and Volatile Oils. That powerful excitation of the movements of

the stomach which is called emesis or vomiting, will be specially described in the next chapter.

Per contra, the gastric movements may be directly diminished by Diluted Hydrocyanic Acid, Opium and Morphia, Carbonic Acid and all effervescing drinks; by the Alkalies, which reduce acidity; as well as indirectly by remedies which soothe the nerves and the vessels, as we have seen.

6. We have already referred to our influence on the *contents* of the stomach—to the food, and to the acidity of the chyme. The reaction may be neutralised or completely changed by Alkalies or Alkaline earths, which are thus **antacids**. Beyond these, Charcoal absorbs the gaseous products of digestion; whilst Sulphurous Acid, Sulphites and Hyposulphites, Carbolic Acid, Creasote, the Aromatic Oils, and possibly all Bitters and Vegetable Astringents in some degree correct decomposition—**gastric disinfectants**. In this connection mention must be made of many **antidotes**, which act upon poisons in the stomach.

7. *Action of carminatives.*—The effects of Aromatic and Pungent Oils of Alcohol, and Ether, in rousing the nerves of the stomach, in increasing the activity of the gastric circulation, in exciting muscular contraction, and in modifying the contents, have been separately described; and we may add that they probably at the same time relax the cardiac orifice. The result is eructation, and relief of gaseous distention, of cramps and pain, the whole being so striking and complete that these substances have been grouped together under the special name of **carminatives** (*carmino*, I soothe). Their effect is, however, more than local. The nervous impressions produced by carminatives spread even beyond the stomach and its sympathetic ganglia to the cord, medulla, and brain, and reflexly to the heart and vessels, and cause general stimulation, both of the bodily and the mental faculties. Carminatives are thus one form of ***diffusible stimulants***.

III. PATHOLOGICAL RELATIONS.

Derangement of gastric digestion, or dyspepsia, is probably the most common disorder of the human body, and may be taken to illustrate, in a general way, the rational treatment of diseases of the stomach.

By far the most frequent causes of derangement of the stomach are to be found in the quantity and quality of the food; in its imperfect mastication and insalivation; in deficiency or in excess of fluids, which dilute the gastric juice and check secretion; and in the abuse of alcohol. Certain drugs in common use are also apt to cause indigestion, such as Opium, Arsenic, Iron, Digitalis, and Scilla. Organic disease of the stomach itself necessarily leads to the same result. Excess of the gastric juice is rare. As a rule, the juice is deficient in relation to the amount of food taken, whether from excess of the latter or from absolute diminution in the secretion, for instance, in debility after illness. Again, either the pepsin or the hydrochloric acid may be deficient, or impeded in its special action. Gastric indigestion is occasionally of nervous origin: depressing mental states readily arrest the action of the stomach; and morbid impressions, originating in the liver, intestines, kidneys, or uterus, often have the same effect.

Disorder of the muscular functions of the stomach may also cause dyspepsia. Feebleness of the churning movements leads to imperfect exposure of the food to the action of the juice; feebleness of the expulsive efforts delays the removal of the chyme, *excess of which arrests digestion.* In other cases, excessive peristalsis hurries the food into the duodenum before the process of gastric digestion has well commenced.

If from any of these or from other causes, the contact of the food and the gastric juice be deficient, the process of digestion becomes disturbed. The secretion, unable to effect complete conversion of the proteids into peptones, produces some partial chemical change in them; the other constituents of the food are also broken up; and—what with the unnatural products, and, in the case of a heavy meal, the excess of peptones themselves—the process of digestion is completely arrested. A decomposition occurs, associated with the formation of organic acids; the sugar, starch, and fat probably become partially changed; and the contents of the stomach are converted—not into the normal chyme, but into a sour, fermenting mass with abundant development of gas. The stomach becomes distended, and the neighbouring organs impeded in their action, especially the heart. The nerves, vessels, and glands of the stomach are irritated by the products, so that the mucous membrane swells; the rosy hue passes into pallor; and the surface is coated with a tenacious mucus. The gastric and associated centres are powerfully excited; and impulses are sent out which lead to hiccup, eructation, and vomiting. If these do not give relief, the contents pass into the bowel, irritate it also by their excessive acidity, and give rise to duodenal dyspepsia and diarrhœa. Even when the urgent symptoms have subsided, the morbid anatomical condition remains for a time associated with an excessive secretion of mucus; the digestive power is arrested; pain and fulness are felt; and loss of appetite (anorexia) and nausea are complained of. All these symptoms will call for relief by treatment.

In *chronic dyspepsia* the attacks are much less severe, but practically continuous. This often depends on other morbid states of the stomach such as cancer; or on disease of other organs, for instance, the kidney, or of the system generally, such as gout, or tuberculosis. The muscular power of the stomach also becomes weak in chronic dyspepsia, the peristaltic movements less vigorous, the organ possibly dilated, and the action of the orifices disordered.

IV. NATURAL RECOVERY.

Acute dyspepsia generally passes off within so many hours or days if left entirely without treatment, vomiting being obviously a natural provision for its relief, and the subsequent nausea or anorexia a means of preventing the introduction of fresh food and affording the stomach temporary rest. These are valuable suggestions for treatment. The duration and degree of suffering in acute indigestion may, however, be considerable; and the violence of the symptoms, such as vomiting, may lead to injury or permanent disease. Therapeutical interference is therefore essential. Organic diseases of the stomach are frequently beyond treatment in themselves, but most of the distressing symptoms by which they are attended, are perfectly capable of relief.

V. THERAPEUTICS.

The conclusion to be drawn from the considerations in the preceding sections is manifestly to the effect that certain disorders and diseases of the stomach are capable of rational treatment.

1. *Prophylactic Treatment.*—Prevention is essentially the proper means of treating dyspepsia. The common causes of disorder, and the opportunity of removing them, are constantly at hand. Prevention here lies almost entirely in the direction of diet, and includes care with respect to the quantity and quality of the food, the frequency and general arrangement of the meals, the circumstances, social and otherwise, under which the food is taken, the thorough performance of digestion in the mouth, the amount of fluids with meals, including alcohol, and other matters which do not call for discussion here. *Dieting is the most important part of the treatment of indigestion:* without attention to it, medicinal treatment is of no avail.

Next to the food, the most ready, but not the most advisable, means of preventing dyspepsia is furnished by the gastric juice itself, or its important constituents, artificially administered. Hydrochloric Acid and Pepsin may be given alone or combined, either during or immediately after meals; or the food may be previously peptonised by the addition to it in the process of cooking, of a digestive extract, made from the mucous membrane of the stomach, or from the pancreas, of the calf or pig.

The therapeutist should endeavour, however, to adopt a much less artificial method of treatment than this. He should try to call into play some of the influences to which the gastric flow is peculiarly sensitive, and thus to increase the natural juice, instead of borrowing its constituents from other sources. First, he will ensure a certain mechanical effect of the food on the stomach, by seeing that "slops" are not indulged in, at the same time remembering that a small quantity of a warm nutritive fluid dish, such as soup, which will be quickly absorbed and stimulate the follicles, is the best commencement of a considerable meal. Drugs will also be prescribed. The most powerful medicinal stimulants of gastric activity must reach the stomach distinctly before meals. Those which increase the activity of the nerves and vessels, and indirectly the activity of the glands and muscles, namely alcoholic, aromatic, bitter and pungent stomachics, are best given in combination, *e.g.* the tinctures of Gentian, Orange, Cascarilla, Chiretta, etc., variously combined with spirits such as Spiritus Ammoniæ Aromaticus, Spiritus Myristicæ, Spiritus Armoraceæ, or Spiritus Chloroformi. A still more powerful gastric stimulant is to be combined with these, viz. an alkaline stomachic, in the form of a preparation of Potash, Soda, or Ammonia, the Bicarbonate of Soda being, for many reasons, the salt most frequently selected. Let it be carefully noted that the alkali must be given with the aromatic bitters, *shortly before meals.* This constitutes the routine medicinal treatment of dyspepsia, and we may repeat that the same result is obtained by successful insalivation of the food, of which the method is but an artificial imitation. The mental occupation and general surroundings of the patient, as well as the times and amount of physical exercise with relation to meals, will also require to be carefully regulated.

2. *Immediate treatment.*—If acute dyspepsia be actually present, it is too late to attempt to stimulate the gastric flow. We must make our choice whether we shall evacuate the stomach, or neutralise the acidity and absorb the gas which are causing the distress. The use of emetics will be described in the next chapter. If the alternative measure be chosen, we give a dose of alkali or an alkaline earth—not, let it be observed, as an alkaline stomachic, but purely as an *antacid to the contents* of the stomach. Bicarbonate of Soda is again the means commonly chosen for the purpose, combined probably with Carbonate of Ammonia and an aromatic oil, such as Peppermint or Ginger,

or more elegantly with Spiritus Ammoniæ Aromaticus, to act as a carminative. The result is that the acidity of the contents is reduced—and it is remarkable how small may be the quantity of alkali required for this purpose—so that the mass passes with comparative safety into the duodenum. Instead of Soda, Magnesia or its Carbonate is occasionally used as an antacid, which, being also a purgative, hastens the expulsion of the offending contents. Gas may be partly absorbed by charcoal, given in powder or in the form of lozenges or biscuits, and partly removed by eructation induced by the carminative, which will further help to arrest decomposition, relieve pain, and rouse the heart and nervous system from the state of depression caused by the attack.

3. *Treatment of the effects.*—When the process of indigestion is at an end, and prostration requires to be relieved, the therapeutist will avail himself of some of the many gastric sedatives at his disposal, of which Diluted Hydrocyanic Acid, Bismuth, and Morphia (whether given subcutaneously, applied to the epigastrium endermically, or combined in an effervescing mixture) will be found the most useful. Champagne or effervescing Soda-Water and Brandy will serve at once as a gastric sedative and a general stimulant, or Milk with Lime-Water or Soda-Water may be given as a sedative and nutritive. Ice is the best means of relieving thirst; in other cases water as hot as can be drunk often acts as a valuable sedative. Linseed poultices, hot fomentations, or warm compresses may be ordered to the epigastrium, and in severe and persistent cases Mustard or Cantharides blisters. The chief problem will be to support the strength without increasing the pain and sickness, and in very urgent cases the patient must be fed by the rectum.

The greatest caution must be exercised in resuming gastric digestion. The best treatment, unless the patient be very weak, is to rest the stomach absolutely for many hours. Fortunately, anorexia conduces to secure this end. The first food given should be in the smallest possible bulk, and of the blandest and most digestible kind, such as broths, essences, meat juices, and milk; and just before each meal a small dose of a mixed stomachic, such as Bicarbonate of Soda, with Diluted Hydrocyanic Acid or Bismuth, and a mild aromatic bitter, such as Gentian, should be prescribed, which will restore the secretion of gastric juice and arrest the flow of alkaline mucus set up by the dyspepsia.

4. *Chronic Dyspepsia* is rationally treated on the same principles as the acute form of the disorder, with certain modifications, which a careful consideration of the pathological associations of the particular case and general experience will suggest. The

patient's diet will require constant supervision. The possible causes of indigestion, beyond food, must be searched for, such as disorder of the liver or bowels, of the heart or kidneys, gout or tuberculosis, and the treatment must be arranged accordingly.

The flow of juice may still require stimulating by Alkalies, but these remedies must not be overdone, as they tend to depress the muscular and cardiac energy. The *digestive adjuvants*, Pepsin or Diluted Hydrochloric Acid or both, may now more rationally be brought to the relief of the failing secretion, being given during or at the end of meals. In still more chronic cases, *e.g.* in aged persons, where chronic indigestion depends on wasting of the glandular structures, peptonised foods will be of great service. In most cases of chronic dyspepsia, the nervo-muscular structures of the stomach require to be strengthened, and distension or overfulness of the organ avoided. Flatulent substances must be excluded from the diet, such as green vegetables, sweets, sloppy food, and large draughts of strong, hot tea. Powerful bitters, such as Strychnia and Quinia, the former being peculiarly valuable as a specific nervo-muscular stimulant, and Diluted Nitric and Phosphoric acids—in short, *stomachic tonics*—are given to increase the functional and nutritive vigour of the muscular coat. In some of these cases *gastric disinfectants*, such as Creasote and the Sulphites or Hyposulphites, may be required to cleanse the contents and surface of the organ, and destroy the organisms of putrefactive and fermentive processes.

Chronic dyspeptics always suffer from starvation to a degree, and the food selected for them must be nutritious as well as digestible. Alcohol in proper form and amount may be required, and bland preparations of Iron, such as the Ammonio-citrate, ordered at intervals, if they can be taken without increasing the dyspepsia. If the dyspepsia depend on a chronic catarrh of the stomach with excessive secretion of mucus, *gastric astringents* will manifestly be indicated, such as Oxide of Silver or Zinc, or Kino, Cinnamon, and other substances containing Tannin.

The treatment of *organic disease* of the stomach cannot be discussed here, but it is hoped that the student will understand from what he has learned, the principles which he must follow to fulfil the most urgent indications in this class of cases also: to relieve pain and sickness, and to insure functional rest of the stomach, remembering that many of the symptoms are referable to dyspepsia.

The therapeutics of vomiting, and incidentally of certain other associated disorders of the stomach, will be discussed in the next chapter.

Synopsis of Drugs which act upon the Stomach.

Alkaline Stomachics.

- Liquor Potassæ
- Potassæ Bicarb.
- Sodæ Bicarb.
- Ammoniæ Carb.
- Spiritus Ammon. Aromaticus
- Magnesia
- Magnesia Levis
- Magnesiæ Carbonas
- Magnesiæ Carbonas Levis

Bitter Stomachics.

As in the Mouth

Aromatic Stomachics.

As in the Mouth

Aromatic - Bitter Stomachics.

As in the Mouth

Spirituous Stomachics.

- Alcohol (in all forms)
- Ether
- Chloroform

Acid Stomachics.

- Acidum Sulphuricum Dilutum
- Acidum Hydrochloricum Dilutum
- Acidum Nitricum Dilutum
- Acidum Nitro-Hydrochloricum Dilutum
- Acidum Phosphoricum Dilutum
- Acidum Aceticum

Pungent Stomachics.

- Piper
- Cubeba
- Capsicum
- Sinapis
- Armoracea

Nervo-Muscular Stimulants, or Stomachic Tonics

- Mineral Acids
- Nux Vomica
- Strychnia
- Bitter Stomachics
- Aromatic Stomachics
- Bitter Aromatic Stomachics
- Spirituous Stomachics
- Pungent Stomachics

Stimulants, becoming Irritants and Emetics.

- Iodum
- Tabacum (in excess)
- Scilla
- Digitalis
- Veratria
- Colchicum
- Senega
- Copaiba
- Cambogia
- Guaiacum
- Ferrum
- Hydrargyrum
- Arsenicum

Digestive Adjuvants

- Pepsina
- Acid Hydrochloricum Dilutum

Nervo-Muscular Depressants.

- Hot Water
- Belladonna
- Hyoscyamus
- Stramonium
- Acidum Hydrocyanicum
- Opium
- Carbonic Acid
- Ice
- Tabacum (at first)

Gastric Astringents.

- Acid. Tannic.
- Argenti Oxidum
- Plumbi Acetas
- Zinci Oxidum

Antacids.

- Potassa
- Soda
- Lithia
- Ammonia
- Calcium
- Magnesia

Mechanical Sedatives.

- Bismuthi Carbonas
- Bismuthi Subnitras

Sedatives of Obscure Action.

- Cerii Oxalas
- Ipecacuanha

Gastric Disinfectants.

- Carbo
- Tannicum
- Creasota
- Acidum Sulphurosum
- Sulphite of Soda
- Hypo-Sulphite of Soda

Carminatives.

- Camphora
- Serpentaria
- Assafœtida
- Ammoniacum
- Valeriana

- All Aromatics
- Aromatic Bitters
- Spirituous Stomachics
- Pungent Stomachics

CHAPTER IV.

EMETICS AND VOMITING.

I. PHYSIOLOGICAL RELATIONS.

VOMITING is a complex act, in which the respiratory muscles, the abdominal walls, the walls of the stomach, the sphincter of the cardiac orifice, and the œsophagus and pharynx participate. Occasionally it is to be regarded as a strictly physiological process for removing excess of food from the stomach, as in the regular sickness of infants after a full meal of milk. It is determined and directed by an elaborate nervous mechanism, consisting of a special centre, the *vomiting centre*, in the medulla; of *afferent* nerves from the fauces, stomach, abdominal viscera, and peritoneum, the chief of which are the glosso-pharyngeal, vagus, and sympathetic, and, indeed, from other parts of the body—the sensory nerves generally; and of *efferent* nerves (the vagus, phrenic, and intercostals) to the muscles, cardiac orifice, and certain associated parts to be presently mentioned. Vomiting may be induced by impressions originating in the areæ supplied by any of the afferent nerves; by stimulation of the centre by certain substances which reach it through the blood; or by the downward flow to it of certain mental impressions, such as nauseous tastes, foul smells, disgusting or terrifying sights, and depressing ideas.

With the evacuation of the stomach there occur certain *associated acts* which are of great importance to the therapeutist. A flow of saliva may precede vomiting, as is well seen in some reflex cases. The gall bladder may be forcibly emptied of bile, which regurgitates into the stomach and is vomited. Expiratory movements, such as sneezing and coughing, frequently occur at the beginning of sickness, indicating the spread of the stimulant impressions to the associated respiratory centre in the medulla; and it must be carefully observed that an expiratory effect is also produced by compression of the chest during the evacuation of the contents of the stomach, as well as at the end of the act, when the air is forcibly expelled through the larynx to prevent the entrance of solid particles. Thus vomiting tends to empty the respiratory passages, as well as the upper part of the alimentary canal. The stimulant effect of emetics on the salivary flow is frequently accompanied by a secretion of bronchial mucus; and this being expelled by the upward current of air, tends further to clear the passages.

Whilst the respiratory and gastric centres are thus powerfully stimulated in vomiting, the cardiac and vascular centres are greatly depressed, the action of the heart and the pulse being reduced in force—at least, between the acts of sickness, and a sense of faintness and giddiness overspreading the patient from further cerebral anæmia. At the same time, the motor centres in the brain, and probably in the cord, are lowered, leading to prostration and inability to support the weight of the body, and compelling recumbency. Lastly, the centres of perspiration are stimulated, causing the profuse sweating familiar in many cases of sickness. Altogether, the student will appreciate how extensive is the physiological disturbance produced by vomiting, and how great is the influence which it furnishes us over several of the most important functions of the body.

II. PHARMACODYNAMICS.

Vomiting may be excited by certain substances and measures, which are called **emetics.** Emetics are said to be either (1) **direct,** when they act upon the stomach itself; or (2) **indirect,** when they act upon the vomiting centre or some other part of the nervous mechanism. *Direct* emetics are the larger of the two classes. They include *warm* water, Infusion of Chamomile, Salt and Water, Mustard, Carbonate of Ammonia, Sulphate of Zinc, Alum, and Sulphate of Copper. They are necessarily given by the mouth. *Indirect* emetics are a small group of drugs, including only Ipecacuanha, Antimony, and Apomorphia. These excite vomiting by whatever channel they may be admitted into the blood—subcutaneously, by the mouth, or by the rectum. For the same reason they produce greater general depression, that is, depress the other vital centres in the medulla more than moderate doses of the direct emetics. Physical irritation of the fauces is a ready emetic measure of the indirect class; and nauseous drugs, such as castor oil and rhubarb, frequently act on the nerves of the same part, but are not given with this intention. Ipecacuanha and Antimony act on the stomach as well as on the centre, and are really, therefore, **direct and indirect emetics.**

The means at our disposal for *averting or arresting vomiting* are as various as the parts of the extensive mechanism upon which they act. They may be called **anti-emetics.** First of these may be mentioned the measures which *reduce the irritability of the vomiting centre,* such as the recumbent posture, nourishing food, Amyl-Nitrite, Nitro-Glycerine, Alcohol, Opium, Chloral, the Bromides, and Diluted Hydrocyanic Acid. A second class, more readily available, comprise the *sedatives of* *the afferent nerves* from the stomach, such as *Hot* Water, Ice, Diluted Hydrocyanic Acid, Carbonic Acid, Bismuth, Dilute Alkalies, Opium, Ipecacuanha and Calomel in small doses; measures which act *indirectly* upon the stomach and reduce the irritability of its nerves, such as poultices or blisters to the epigastrium; and *sedatives of the afferent nerves to the vomiting centre from other organs*, for instance, demulcents to the throat, poultices to the abdomen, or applications to the os uteri.

III. PATHOLOGICAL RELATIONS.

Vomiting being regarded for our present purpose as a physiological act, it may be considered to be disordered, (1) if *excessive;* and (2) if *defective, insufficient, or absent* when it would be salutary or desirable. We will illustrate each of these conditions.

1. *Excessive vomiting* occurs as the result of disorder or disease of the stomach; morbid conditions of other parts of the abdomen, such as hernia, cough, severe pain, injury or disease of the brain, or disturbance of the circulation and senses, including sea-sickness. The cause of vomiting may be in the centre itself, especially as a consequence of previous violent vomiting, or of urea and certain extrinsic poisons, such as antimony.

2. *Defective vomiting* may be said to occur when only attempts at retching ensue on the presence of direct or indirect stimulation of the centre. In the vast majority of cases, however, we have to deal with conditions in which, whilst vomiting is urgently demanded, no attempt at vomiting is made by nature, the substances which require to be expelled from the stomach being of a non-irritant or even sedative nature, such as narcotic poisons. This introduces us, further, to the use of emetics for other purposes than simple evacuation of the stomach. Vomiting may be desired for the sake of obtaining one or more of the associated effects on other viscera. In certain inflammatory diseases of the larynx and bronchi, such as croup and bronchitis, which are attended by the production of thick or solid products, or whooping cough, which is characterised by defective or disordered expulsive power, an emetic will be indicated to empty the respiratory passages and restore the free entrance of air. Similarly, rigidity of the cervix uteri in the first stage of labour is believed by some obstetricians to call for emetics which shall relax the uterine sphincter.

IV. NATURAL RECOVERY.

Vomiting usually ceases with the removal of its cause, but it may persist indefinitely, until the therapeutist steps in.

Whilst it is in itself a natural provision for relief, there is a limit to its beneficial effect. Protracted vomiting appears to increase the irritability of the mucous membrane and nerves of the stomach, and thus to tend to go from bad to worse; and the same is the case with the vomiting centre, which may become so sensitive as a consequence of sickness that the slightest change of posture brings on the symptom afresh. There is urgent need for treatment in such cases.

V. THERAPEUTICS.

The therapeutical relations of vomiting, rationally considered, are obvious. Excessive vomiting has to be arrested; vomiting may have to be assisted when it is ineffectual, or excited when entirely absent; and the action of emetics may be taken advantage of for other purposes than to empty the stomach.

1. *Excessive Vomiting.*—The study of the physiology and pathology of vomiting serves to impress upon the student the absolute necessity for diagnosis, or investigation of the cause of disorder, before rational therapeutics can be carried out, and the thoroughly unscientific and unsatisfactory character of the practice which applies treatment to symptoms without ascertaining the pathological condition on which they depend. How extremely irrational it would be to attempt to relieve by the same means the vomiting caused by indigestible food at the commencement of acute indigestion, and the vomiting due to the swelling which persists in the second stage. At the former period, vomiting is relieved by temporarily encouraging it by a good emetic; at the second period, the very opposite set of measures—gastric sedatives—must be employed.

The first step to be taken manifestly is to attempt to *remove the originating cause* of the reflex act. If the stomach contain irritant food, it must be quickly neutralised, as we saw in the last chapter; if a poison, some antidote must immediately be administered; or either of the two may be removed from the stomach by facilitating and completing vomiting, or by means of the pump. Once emptied, the stomach must be quieted by the gastric sedatives studied in the last chapter. If the cause be discovered in any of the other abdominal organs, the same plan of removal, if possible, must be pursued. Vomiting originating in injury or disease of the brain will call for the special treatment proper in such cases, and the free use of nervous sedatives, such as the Bromides of Potassium and Ammonium. If the vomiting centre is being irritated by some intrinsic poison such as urea, or an extrinsic poison such as antimony, the excretion of the morbid substance by the kidneys, skin, or bowels, must be hastened, or its effects antagonised by stimulants.

If, on the other hand, disturbance of the circulation in the centre be the cause of the vomiting, we must restore the normal supply of blood by keeping the patient in the recumbent posture and insuring bodily rest, and stimulate the circulation by Alcohol and food, if they can be retained in the stomach. Nitro-glycerine, Nitrite of Amyl, and Chloral appear to have been given with some success under these circumstances.

When the cause cannot be removed we must reduce the irritability of the centre by Opium or similar drugs.

2. *Defective Vomiting: Use of Emetics.*—The adoption of vomiting as a therapeutic measure, and the selection of an emetic from the list just given, are matters of the greatest practical importance. The student must not think that in inducing vomiting we are effecting a simple mechanical act of evacuation; he must appreciate the extent and degree of physiological disturbance which we are setting up. If the patient be very weak, the therapeutist may be alarmed to find that his emetics or unsuccessful attempts at emesis are followed by intense circulatory depression, faintness, and even threatening dissolution. The condition of the patient must be carefully, if quickly, ascertained; and if vomiting be considered a justifiable and proper method of treatment, a selection must be made of one or other emetic, according to the patient's strength and other circumstances. Fortunately, in most cases of acute poisoning, where vomiting is urgently indicated, the patient is able to bear the shock, and Sulphate of Zinc, twenty grains in two ounces water, Sulphate of Copper, two to five grains in an ounce of water, or a table-spoonful of Mustard in a cupful of hot water, should be given without delay. Where blocking of the respiratory passages by the products of croup or bronchitis calls for an emetic, great judgment is required to estimate the patient's strength and to select a proper emetic, if any. Vinum Ipecacuanhæ, in doses of 1 fl.dr. for children, or $\frac{1}{2}$ fl.oz. for adults, is the best, because it is also an expectorant. Antimony is decidedly more depressing, in doses of 1 to 2 gr. of Tartarated Antimony, or $\frac{1}{2}$ fl.oz. of Vinum Antimoniale for an adult. Carbonate of Ammonia is a suitable emetic in these cases, being a stimulant to the heart and respiration. In acute dyspepsia the mildest emetics are indicated, including tepid water, Salt and water, warm nauseous infusions such as Chamomile; and may be freely given. Apomorphia is at once the most certain and generally applicable, whilst the least employed of emetics, because rarely at hand. $\frac{1}{16}$ gr. may be given subcutaneously, or a dose of $\frac{1}{8}$ gr. by the mouth. It is frequently necessary to follow an emetic by a stimulant, such as alcohol.

SYNOPSIS OF REMEDIES WHICH INFLUENCE VOMITING.

EMETICS.			ANTI-EMETICS.	
DIRECT.	INDIRECT.	DIRECT AND INDIRECT.		
Anthemis	Apomorphia	Antimonium Tartaratum	Acting through the centre.	Opium
Sinapis		Ipecacuanha		Ammonii Bromidum
Ammoniæ Carbonas				Potassii Bromidum
Alumen				Chloral Hydras
Cupri Sulphas				Alcohol
Zinci Sulphas				Food
Sodii Chloridum				Amyl Nitris
Tepid Water				Nitro-Glycerine
				Acidum Hydrocyanicum Dilutum
			Acting through the gastric nerves.	Hot Water
				Acidum Hydrocyanicum Dilutum
				Carbonic Acid
				Bismuthum
				Dilute Alkalies
				Opium
				Ipecacuanha (in small doses)
				Calomel (in small doses)

CHAPTER V.

DIGESTION—THE DUODENUM.

WE are now in a position to follow the process of digestion in the duodenum. The other functions of the intestine will be considered in the next chapter.

I. PHYSIOLOGICAL RELATIONS.

The chyme passes out of the stomach with an acid reaction, and its undigested constituents are at once subjected to a second process of digestion in the duodenum by an *alkaline* fluid, which is a mixture of the pancreatic juice, the bile, and the enteric juice. The pancreatic juice converts the remaining starch into sugars, and the remaining proteids into peptones, leucin, tyrosin, and fatty acids; whilst in association with the bile it partly emulsifies and partly saponifies the fats. The sugars are converted into lactic acid and butyric acid, possibly in part by the succus entericus, which is also amylolytic. These products of duodenal digestion, as well as those of gastric digestion, are absorbed into the portal and lymphatic systems; whilst the undigested portions of the food and various excretions are further acted on by the bowel, and become the fæces.

Just as the acid gastric juice was stimulated to flow by the alkaline reaction of the insalivated food, so the three great alkaline secretions entering the intestine are stimulated to flow by the acid chyme. Moderate acidity of the contents, as they enter the duodenum, is manifestly the most favourable to intestinal digestion, excessive acidity tending to neutralise the alkaline fluids, and render them inert.

The nervous mechanism which regulates each of the three secretions is comparatively obscure; but they appear to be governed, like the gastric functions, both by local ganglia and by centres in the medulla, between which and the viscera there pass the vagus and sympathetic, as afferent and efferent, nerves. The vessels of the parts, so far as is known, are dilated during functional activity. The muscular movements are still, as in the stomach, partly progressive and partly churning, but the former decidedly preponderate.

II. PHARMACODYNAMICS.

In pursuing the contents of the alimentary canal from the stomach into the duodenum, the pharmacologist becomes conscious of a decided loss of control over them when they have passed the pylorus. The chyme is now practically beyond recall upwards by vomiting; and the chemical or physiological effects which could be produced by drugs in the mouth and stomach can only be imperfectly copied in the intestines. Yet a closer examination of the influences on duodenal digestion which are in our power is reassuring.

The *food* can be modified in any direction we may think fit, and the proportion of fatty and starchy principles specially arranged to affect intestinal digestion; or the liver, pancreas, and duodenal glands may be allowed to enjoy physiological rest by abstinence from food. The food may be specially cooked in combination with an extract of pancreas and an alkali, and thus thoroughly "peptonised" or pancreatised before it is taken. Starch may be partly converted into maltose and dextrin—Extract of Malt or maltine. If evacuation of the duodenum by the mouth be practically impossible, we may expel its contents downwards by the use of purgatives, which will be presently studied.

A more complex problem meets us when we attempt to affect the *secretions* of the liver, pancreas, and intestinal glands. We cannot directly increase the alkalinity of the secretions, as we increase the acidity of the gastric juice by a dose of diluted hydrochloric acid after meals; for any alkali given by the mouth is neutralised in the stomach before it reaches the duodenum. For the same reason we cannot administer pancreatic juice by the mouth as we can give pepsin, for its ferment is destroyed at once in the stomach. Malt extract contains an amount of active diastase, which, however, is also destroyed in the stomach, unless the extract be given at the very end of gastric digestion, when the acid is exhausted. We possess, however, equally physiological and less artificial means for stimulating the duodenal secretions. First, by influencing gastric digestion we can transmit the chyme into the duodenum with greater acidity, an **indirect duodenal stimulant** measure. Secondly, acids, such as Diluted Nitric, Nitro-hydrochloric, or Phosphoric Acid, given after meals, will be conveyed in the chyme to the mouths of the ducts, and act as **direct duodenal stimulants**; and it is possible that these may have a further influence in the same direction by being absorbed from the stomach and reaching the liver and pancreas through the blood. Ether is believed by some to stimulate the pancreas, and probably assists in emulsifying oils. On the other hand, an alkali given before meals will stimulate duodenal digestion by improving gastric digestion; whilst an alkali given after meals would interfere with duodenal digestion by diminishing the natural and necessary acidity of the chyme.

We possess a considerable number of substances which increase the flow of bile, which are designated **cholagogues.** Cholagogues are either *direct*, when they act upon the liver itself; or *indirect*, when they stimulate the liver by sweeping the intestinal bile out of the body. These facts may be accepted temporarily in connection with the digestive function of the bile; they will be fully discussed along with the purgative function of the bile in the sixth chapter. Mercurials not only clear the duodenum of chyme and bile, and furnish it with a supply freshly secreted, but also stimulate the duodenal glands, and thus have a remarkably stimulant influence on digestion.

III. PATHOLOGICAL RELATIONS.

Duodenal dyspepsia is not uncommon, and may be either *secondary* or *primary*. The *secondary* form is the necessary consequence of gastric indigestion. The acid decomposing mass which passes the pylorus in acute gastric dyspepsia completely neutralises the alkaline secretions of the duodenum; the remaining proteids, fats, starches, and sugars, undergo further decomposition, instead of the proper chemical transformation; absorption is arrested; the peristaltic movements are unnaturally increased; and the contents are hurried through the bowel, and violently expelled—the whole constituting the diarrhœa of acute indigestion, familiar to all. At the same time, pain is felt in the abdomen as the result of the powerful impressions on the afferent nerves, attended by a sense of misery and depression. *Primary* acute duodenal dyspepsia closely resembles the disorder just described, except that it is not preceded by gastric symptoms, and constitutes another form of diarrhœa. As in the case of the stomach, the chief cause of the derangement is improper feeding, including excess of those principles which tax the activity of the liver and pancreas, namely, fats, sugars, and, in infants, starchy materials. In other instances, the bile may be deficient. The flow of pancreatic juice is sometimes diminished by nausea and vomiting, as well as by other circumstances. Nervous and mental depression also interfere with the action of the secreting glands, and may lead to indigestion and diarrhœa.

In chronic cases disturbance of the natural relations between the duodenal juices and the chyme produces less urgent symptoms, but leads to more serious impairment of nutrition. Pain, "heart-burn," and depression, come on within a few hours after meals. The bowels are irregularly moved; and the motions are apt to be pale and foul, and may contain undigested fat and milk. The same symptoms in an aggravated form accompany organic disease of the duodenum, liver, and pancreas. Disorders and diseases of the liver have, however, an interest much beyond their bearing on digestion, and will be separately discussed.

IV. NATURAL RECOVERY.

Little requires to be said under this head. Diarrhœa is manifestly a natural provision for relieving the duodenum of unsuitable contents, as vomiting relieves the stomach. Even if this be excessive, and give rise to general disturbance, the duodenal function soon becomes normal, when the cause of disorder has been removed. A thorough appreciation of all the facts of the case manifestly suggests that the province of the therapeutist is not to prevent or check these salutary efforts unless excessive; and to help Nature to recover herself more speedily and more surely than she might otherwise be able to do.

V. THERAPEUTICS.

As in the stomach, the rational treatment of disorder of the duodenum is either *preventive* or *immediate*. Duodenal dyspepsia may be prevented from returning in persons predisposed to it by careful regulation of the quality, quantity, and preparation of the food. The patient must be ordered to eat sparingly of fatty, sweet, and starchy foods, and to avoid richly-cooked dishes, which generally contain fats in various stages of chemical decomposition. In extreme cases it may be necessary to ensure the digestion of a mixture of the proximate principles of a healthy diet, such as milk and bread or gruel, by peptonising them with an extract of pancreas before they are eaten. Malt extract, which supplies sugar in a form ready for absorption and incapable of fermentation, will be suitable in some cases, but attention must be paid to the time of its administration with relation to meals. Next to the food, the therapeutist will do wisely to attend carefully to the gastric functions, remembering that it is in this way that he will most rationally restore the chemical and physiological balance in the upper part of the intestine. He may elect to give an alkali shortly before meals to secure this end, or he may prefer to administer acids after meals according to the directions already given under the head of gastric digestion. In the former instance he increases the acidity of the chyme physiologically; in the latter instance by simple chemical means.

2. The *immediate* treatment of an attack of acute duodenal dyspepsia will generally follow, as we have seen, upon the treatment of acute indigestion in the stomach. We have studied the beneficial effects of neutralising the excessive acidity of gastric dyspepsia, by means of an alkali combined with a carminative and stimulant, and it is obvious that this will be continued after the chyme has left the stomach. When treated with a full dose of Bicarbonate of Soda and Sal-volatile, it enters the intestine with an acidity probably below the normal, reduces the higher acidity of the irritant chyme already there, and restores the normal action of the glands. If we are called too late to relieve duodenal indigestion in this way, the most rational course that we can adopt is to clear away the offending contents by purgation. Magnesia or its Carbonate act well in these cases, being immediately antacid, and afterwards laxative. More frequently a simple cholagogue purgative should be administered, such as Calomel, which has the further advantage of not disturbing the stomach by its taste or bulk.

Any pain and excessive muscular movements (colic) which may remain, must be treated by sedative remedies, such as Opium or Bismuth. The treatment of diarrhœa and the use of cholagogues and purgatives in chronic duodenal disorders, must be reserved till the next chapter.

MEASURES INFLUENCING DIGESTION IN THE DUODENUM.

FOOD.	DIRECT DUODENAL STIMULANTS.	INDIRECT DUODENAL STIMULANTS.	HEPATIC STIMULANTS.
Pancreatised Foods Olive Oil Almond Oil Cod Liver Oil Malt Extract	Diluted Mineral Acids Ether Mercurials	Sialagogues Stomachics Purgatives	Cholagogues Purgatives

CHAPTER VI.

THE INTESTINE.

WE now proceed to the consideration of therapeutical methods founded on a more complex physiological basis, namely, the actions and uses of *purgatives* and *intestinal astringents.*

I. PHYSIOLOGICAL RELATIONS.

As the chyme passes along the small intestine, the chyle and other soluble constituents are absorbed, and what remains is moved onward into the great intestine, where it forms the bulk of the fæces. Along the whole route, fluid is passing in both directions between the intestinal contents and the blood—from the bowel into the vessels, and from the vessels into the bowel. The consistency of the fæces will, therefore, depend upon the activity of absorption, the activity of excretion, and, manifestly, the rate of transit. The more active the absorption, the less active the secretion, and the slower the rate of transit, so much the firmer will be the fæces; whilst liquidity of the fæces will be the result of imperfect absorption, excessive excretion, or rapid transmission. We are accustomed to speak of the one extreme as constipation, and of the other as diarrhœa.

Absorption from the bowel is carried on by the lacteal and portal systems. The great bulk of the water and salts enter the portal system, by a process of diffusion or osmosis. The activity of this process varies greatly—with the amount of water, salts, and proteids in the bowel, as compared with the blood plasma; with the chemical nature of these salts: with the rate of the circulation through the veins—that is, with the state of the liver; and with the condition of the membranes through which the fluids pass.

Excretion is so active in the small intestine that the fæces are as liquid at the ileo-cœcal valve as in the duodenum, *i.e.* the effect of absorption as regards water is entirely neutralised. The watery excretions, along with a small quantity of solids and gases, are separated partly by osmosis from the vessels, partly by the glands, the latter furnishing the succus entericus. The activity of the glands is doubtless dependent upon many influences connected with their vessels and nerves, and with the quality of the blood, which are still imperfectly understood.

The *transit* of the contents of bowels is effected by peristalsis. The muscular coat is innervated by the vagus and splanchnics, the former increasing peristalsis, the latter tending to restrain or inhibit it, just as the vagus inhibits the heart. Whilst the intestine is connected by these means with the cord and brain, its movements are chiefly automatic and determined by Auerbach's and Meissner's plexuses. The state of tension of the wall, the internal pressure of fæces and gas, is the ordinary stimulus of this mechanism; but the nerves or muscles, or both, are also stimulated by the bile; and may be either excited or depressed by many substances introduced through the blood, as we shall see under the next head, as well as (inversely) by the amount of blood supplied to them. In defæcation the will comes to the assistance of the automatic intestinal movements, and effects evacuation of the bowels.

General effects of evacuation of the bowels.—The effects of evacuation of the bowels are by no means purely local. On the contrary, the whole system is influenced by this act, to no great extent, it is true, under normal circumstances, but very markedly when it amounts to actual purgation. When the bowels are very freely moved, a certain amount of water is directly or indirectly removed from the circulation. Bile is swept out of the bowel, and the liver indirectly stimulated. Certain solids and gases excreted by the intestinal wall, that is, truly excrementitious substances, are thrown out of the system. The circulation in the abdomen is disturbed: the vessels are relieved from the pressure of the fæces; the blood flows more freely from the arteries through the portal system and liver; whilst the volume of blood in the portal system and liver is temporarily reduced by the watery excretion. The heart and vessels generally are thus in turn relieved; the blood pressure in the systemic arteries falls; the cerebral circulation is especially depressed on account of its position, so that faintness may be the result; the respiratory movements become easier; the activity of the venous circulation is increased; and the temperature falls. Amongst the abdominal vessels, the circulation through the renal artery and vein is increased, and with it the volume of urine secreted, diuresis being more readily induced after purgation, unless the quantity of water drained off by the bowel have been excessive.

II. PHARMACODYNAMICS.

The means of acting physiologically upon the intestine which are at our command are of a much more artificial kind than any we have yet encountered, and introduce us to a large number of medicinal substances.

1. *Food.* The influence of the food is felt in the bowels, and affords us a ready means of acting upon them. Many kinds of food increase the action of the bowels, notably coarse, indigestible articles of diet, such as the husk of cereals made into "brown bread" and "whole-meal"; green vegetables; oils; fruits, fresh or preserved, which contain abundant salts and sugars; soups, broths, and other preparations of meat; eggs; ale and beer; tea and coffee, when properly prepared; and water taken at bed-time, or in the early morning before breakfast. On the contrary, cold articles of food, milk, spirits, red wines, and tea and coffee made strong and badly, are constipating in their effects. Perfect *digestion* in the mouth, stomach, and duodenum, is one of the most powerful means of preserving or restoring the natural action of the bowels.

We now pass from these natural means of acting upon the bowels, to others of a distinctly medicinal character.

2. *Measures which act upon the intestinal Blood-vessels: Drastics; Astringents; Constringents.*—A number of substances disturb transudation by acting upon the *blood-vessels* in the intestinal walls.

a. Drastics.—These cause the vessels to dilate, and retard the blood current, so that the fluid and part even of the solid constituents of the blood escape into the walls and cavity of the bowel. In other words, they establish an inflammation of the mucosa, somewhat resembling a common "cold" in the nose. The result is similar in the two cases: there is a profuse discharge from the mucous membrane, of the watery part of the blood, with a certain amount of solid elements, constituting a "catarrh," and producing in the case of the bowel a very liquid stool. The drugs which act in this way are obviously powerful or even dangerous, and comprise chiefly Croton Oil, Elaterium, Gamboge, and Colocynth. They constitute a group of purgatives known as **drastics** (δράω, I act) or **drastic cathartics.**

b. Intestinal Astringents.—Opposed to these measures we possess certain substances which contract the walls of the intestinal vessels, reduce the quantity of watery exudation, prevent the escape of solid elements, and thus diminish the liquidity of the fæces. Such substances, include Lead, Silver, and the

Diluted Mineral Acid, and constitute the first group of **intestinal astringents**, called *intestinal vascular astringents.*

c. Intestinal Constringents.—The substances thus named possess the property of coagulating or otherwise condensing the gelatiniform and albuminous tissue supporting the small vessels of the mucosa, increasing its compactness, diminishing the freedom of the circulation, and thus reducing the amount of exudation through the vessel walls. **Intestinal Constringents** are a very large group, including Persalts of Iron, Alum, Sulphate of Copper, Oxide of Zinc, Tannin, and the numerous vegetable products which yield it or some of its modifications, such as Catechu, Kino, Krameria, and Cinnamon.

3. *Measures which influence Absorption and Excretion.—a. Saline Purgatives.*—Certain salts possess the property of greatly disturbing the *process of osmosis* in the intestinal wall, such as the Sulphates of Magnesia, Soda, and Potash; Phosphate of Soda; Tartrate, and Acid Tartrate of Potash; and the Tartrate of Soda and Potash. These produce two effects, namely, first, increased flow of water from the intestinal vessels into the cavity of the bowel, and consequently increased liquidity of the stools; and secondly, a flow of the salts, with a certain amount of water, from the cavity of the bowel into the blood-vessels, whence it is partly carried away into the general circulation, and partly again excreted into the bowel by the intestinal glands, once more to be absorbed. The result is an abundant liquid stool; in the case of Acid Tartrate of Potash, or very large doses of the other salts, almost entirely watery. The precise way in which these effects are produced by saline substances is still obscure. They appear to be due in part to the difference in specific gravity between the watery materials in the bowel and the liquor sanguinis, in part to some specific action of the salts upon the structures of the walls through which they pass, depending on their chemical constitution and affecting dialysis. According to some authorities, saline purgatives act in a measure by stimulating peristalsis.

These salts furnish us with a ready means of increasing the liquidity of the motions and the frequency of the stools, and constitute the group called **saline purgatives,** the most powerful of which are called *hydragogue salines.*

Saline Astringents.—A sufficient amount of salts, and (within broad limits) a particular strength of solution, are required to secure an abundant excretion; otherwise their absorption in watery solution is stimulated beyond their excretion, and constipation instead of relaxation is the result. The same effect is liable to be produced by their habitual employment. We do not use this group of measures therapeutically.

4. *Measures which influence the Intestinal Glands.—a.* The secretions of the intestinal glands are moderately *increased* by Mercurial preparations; greatly increased by Croton Oil, Elaterium, Colocynth, Jalap, Scammony, and Podophyllin, which no doubt act also upon the vessels and muscles. Jalap and Scammony require to be dissolved in the bile. We have just seen that the saline purgatives are also glandular stimulants, being no sooner absorbed than they are again excreted. This class of purgatives may be called **cathartics** (καθαίρω, I cleanse); such of them as produce very watery motions, **hydragogue cathartics.**

b. Opium, Lead, and Lime directly *diminish* the intestinal secretions and promote constipation. Alkalies, Alkaline Earths and their Carbonates interfere with the acidity of the chyme when given in full doses, and thus indirectly arrest the intestinal secretions; whilst, by conversion into sulphates in the bowel, they may become active purgatives. Thus certain saline substances may not only be purgative in more than one way, but may even be purgative and astringent at the same time; the one effect or the other occurring according to the dose, the patient, and other circumstances which are often obscure.

5. *Measures which influence the Nervo-muscular Structures.*—Many of the materiæ medicæ influence the bowels through the *muscular coat*, the *nerves*, or both. Thus drastics excite intestinal peristalsis and griping even before they have left the stomach, as is seen in Croton Oil. Saline purgatives are believed to have the same effect. It is practically convenient to arrange in a special class those substances which act entirely or chiefly upon the intestinal muscles.

a. Nervo-muscular Stimulants. — These include Rhubarb, Senna, Aloes, Castor Oil, Sulphur, Sugars, Nux Vomica, Rhamnus Frangula, Cascara Sagrada, and Belladonna, and many others. They are best given with carminatives, to prevent the intestinal pain caused by excessive or spasmodic muscular contraction, popularly known as "griping," which they readily induce. Belladonna appears to act in a different way from the others, by removing the inhibition of the splanchnic; and ergot by causing anæmia of the muscles. The stool which follows the action of a muscular stimulant is much less watery than that produced by saline or cathartic purgatives, being chiefly the ordinary contents of the small bowel hurried down, unless the drug be given in large doses. For the same reason the disturbance of the portal circulation, liver, the general circulation, and the system as a whole, is less marked. The nervo-muscular purgatives are commonly known as **simple purgatives**; and the mildest of them, such as Castor Oil and

Sulphur, Figs and the like, are classed by themselves as **aperients** (*aperio*, I open), or **laxatives** (*laxo*, I loose), as inducing a simple opening or relaxation of the bowels.

b. Nervo-muscular Intestinal Sedatives.—The drugs which *arrest* the movements of the bowel, either directly or through the nerves, include Opium, Morphia, and Lead, which diminish peristalsis, and may even completely paralyse the bowel. Substances which form a protective lining on the mucosa, and antacids indirectly produce the same effect, by diminishing the irritation of the contents. Bismuth, Chalk, Lime, and Alkalies act, partly at least, in this way. All are **astringents.**

6. *Cholagogues.*—Following naturally on the last class of purgatives comes a group which act indirectly upon the muscular coat, by increasing the flow of its natural stimulant, the bile. These substances are known as **cholagogues** (χολή, bile, and ἄγω, I cause to flow). As will be explained in the next chapter, they either act directly upon the liver-cells and gall-bladder—**direct cholagogues**; or sweep out of the body what bile is lying in the intestine, and thus indirectly stimulate a fresh secretion—**indirect cholagogues.** Direct cholagogues may be illustrated by Podophyllin, Rhubarb, and Sulphate of Soda; indirect cholagogues are chiefly Mercurials. It will be observed that cholagogues and purgatives have complex associations with each other: most purgatives are probably indirect cholagogues; many purgatives happen to be also direct cholagogues; and all cholagogues exert a certain amount of purgative effect, inasmuch as they increase the flow of the natural intestinal stimulant.

We do not deliberately employ **anticholagogue** measures, for *checking* the flow of bile. Opium possesses this action.

Enemata (ἐνίημι, I inject). Many of the remedies just mentioned may be adminstered by enema, that is, injected into the rectum. (1) Food, such as beef tea, eggs, gruel, and milk, and alcoholic stimulants, constitute **nutrient and stimulant enemata.** (2) Intestinal stimulants may be given as **purgative enemata,** chiefly Castor Oil, Olive Oil, and the officinal Enemata of Aloes and Sulphate of Magnesia. (3) Enema Opii is a most valuable **sedative and astringent** preparation. Solutions of Sulphate of Zinc or Copper, Nitrate of Silver, Alum, and Decoctum Quercûs, are also astringent. Enema Tabaci is now very rarely used as a powerful **depressant enema.** The rectum may be mechanically emptied by **simple enemata,** such as warm water, warm soap and water, and thin gruel, which soften the fæces and stimulate the parts. Besides these we possess **anthelmintic enemata**, which remove worms, such as the Enema Terebinthinæ, Enema Aloes, and an enema of bitter infusions, or salt and water. Ice-cold water may be injected into the rectum as an **antipyretic enema**, *i.e.* to reduce the temperature, and as a **styptic enema** in hæmorrhage.

III. PATHOLOGICAL RELATIONS.

As far as our present purpose is concerned, the disturbances of the intestine, independently of its digestive function, which has been already discussed, are chiefly two, namely: excessive action, the striking phenomenon of which is *diarrhœa*, and defective action, characterised by *constipation*.

1. *Excessive Intestinal Action.*—Diarrhœa, as we have seen, is generally referable to gastric or duodenal dyspepsia. The ultimate cause is most commonly improper food, including the various irritant substances which may be admitted along with it, such as unwholesome drinks, the organisms of putrefaction, and the poisons of typhoid fever, dysentery, and cholera. Irritant poisons have the same effect. Certain intestinal irritants are generated in the body itself, such as urea, the poison of gout (chiefly uric acid), and the poison of pyæmia. Nervous disturbances may produce diarrhœa, for example, anxiety and fear. Disorders of the general and abdominal circulation are frequently attended by a watery flow or flux from the bowels, as in diseases of the liver and heart, or as the result of chill. Lastly may be mentioned organic disease of the intestines. The student must carefully note that diarrhœa, although of much importance in itself and as a cause of further disorder, is but a symptom, the anatomical condition on which it depends varying greatly.

In connection with excessive activity of the intestines must be taken here certain conditions, such as hernia, peritonitis, and perforation of the bowel, in which any peristaltic movement of the intestine, however slight, must be considered excessive because highly dangerous, and in which paralysis of the intestine for the time being is urgently required.

2. *Deficient Intestinal Action.*—Constipation is even more common than diarrhœa, and is peculiarly apt to appear in a chronic form. Of its causes, we may select as illustrative examples certain kinds of food, already noticed; chronic gastric and duodenal dyspepsia, especially in connection with biliary disorder; sedentary or careless habits; and certain specific substances, such as lime and lead, admitted in the food or otherwise. Habitual constipation is generally due to loss of irritability and vigour of the nervo-muscular structures from very chronicity of the state and neglect of regular defæcation;

to impairment of the general health by sedentary occupations, foul air, etc.; to a variety of obscure causes, commonly referred to as locality, and change of habits; and to certain organic diseases of the bowel. The most severe and obstinate cases of constipation are caused by paralysis of the bowel in disease of the spinal cord and lead-poisoning. Although constipation, like diarrhœa, is but a symptom, and must be treated as such, its unfavourable effects on digestion, sanguification, and the functions generally, are almost endless.

Along with constipation must be considered a class of cases where disease of the digestive organs, liver, heart, lungs, general circulation, brain, blood, or kidneys, demands free evacuation of the bowels, and, it may be, even a hydragogue or cathartic action, chiefly as a means of unloading the circulation or of evacuating excrementitious substances. Frequent reference will be made to this application of purgation under the several organs in the following chapters.

IV. NATURAL RECOVERY.

Diarrhœa is a striking instance of the first method of natural recovery—by removal of the cause. By this means not only is the bowel purged of irritant matters, but constipation may be naturally relieved by a spontaneous diarrhœa produced by the irritant effect of the retained fæces. Both diarrhœa and constipation, if left entirely to themselves, may spontaneously cease, and the normal action of the bowels return. Therapeutical assistance is, however, constantly valuable, and frequently essential. Thus the diarrhœa of infants may quickly end in fatal exhaustion, and atony of the gut may be the result of neglected constipation.

V. THERAPEUTICS.

1. *Excessive Intestinal Activity; Treatment of Diarrhœa.*—The treatment of diarrhœa should begin, if possible, with *the removal of its cause.* If this is being accomplished by the bowel itself, we must encourage intestinal activity for a time by such purgatives as Castor Oil, Rhubarb, Calomel, Magnesia, and Senna. The first two drugs are specially valuable, as they also possess an astringent action, which comes into force after the purgation. On the same principle, diarrhœa from hepatic or renal disorder or disease, is rationally treated by non-interference or even by a judicious increase of elimination by the bowel, hepatic and renal stimulants being also combined; that is, by the use of a purgative which is partly cholagogue, followed by a diuretic—a mercurial pill supplemented by a

Seidlitz powder. Again, diarrhœa due to acidity in the duodenum is rationally treated by an alkali or alkaline earth, such as Lime-water, Chalk, and Bicarbonate of Soda—a highly successful method in the intestinal dyspepsia of infants. If the cause cannot be removed, its effects may be physically prevented by coating the surface of the bowel with Bismuth.

To *counteract* the irritant influence, astringent measures must be employed; and the two kinds of astringents in general use for this purpose are the constringents and the nervo-muscular intestinal sedatives. Of the former, Tannic Acid is less often used than its allies, between which there is little to choose, such as Catechu, Kino, and Krameria. With the constringent there is usually combined some preparation of opium as a nervo-muscular sedative, in the form of Dover's Powder, Kino, and Opium, or Compound Opium Powder, which relieve pain, diminish the peristaltic movements, check the secretions, and arrest the cramps or tormina. It will be found desirable in almost every case of diarrhœa demanding immediate arrest, to combine a certain amount of opium, however small, with the other drugs. We are now in a position to understand the use of the intestinal *vascular* astringents: Lead, Silver, and Diluted Sulphuric Acid. These are specially indicated in inflammatory conditions of the bowel, such as accompany ulceration in typhoid fever, dysentery, and tuberculosis. Diluted Sulphuric Acid is given when the effect is intended to be speedy and brief. A small quantity of Opium or Morphia is again a powerful adjuvant; for instance, as the Lead and Opium Pill, Diluted Sulphuric Acid and Laudanum, and Dilute Acetic Acid, Acetate of Lead, and Acetate of Morphia combined. In certain cases these remedies may be administered in an enema, the Enema Opii being particularly valuable. Coto Bark is successful in some cases of persistent tubercular diarrhœa. Nervous diarrhœa may be relieved by Bromide of Potassium. Some forms of chronic diarrhœa, and the flux of uræmia (when it can be safely checked), are best treated with Persalts of Iron.

The food is to be ordered in diarrhœa with a view to prevent irritation, and thus contribute to the cure; and dieting must be regarded as of equal importance with the medicinal treatment. The food must be entirely fluid, as a rule, and will consist chiefly of broths and milk. The former must be carefully prepared, without fat or seasoning, and given cold. The milk must be in a form which will not yield a large indigestible curd—itself a source of intestinal derangement, but given with effervescing alkaline waters, or lime-water, or boiled and mixed with some kind of starch, such as arrowroot or rice. Eggs must be used with caution. Ice is the best means of relieving thirst, or sips of toast-water; draughts of all kinds must be avoided. Stimulants may be required by the aged, by infants, and in all cases of protracted diarrhœa, brandy and port wine being the most suitable forms.

2. *Deficient Intestinal Action: The Use of Purgatives.*—The treatment of constipation consists chiefly in careful regulation of the diet, which should include fruits, green vegetables, meats, and "whole" brown bread, whilst milk and strong tea are to be avoided. As a rule, however, its chronic "habitual" form calls for active interference.

In the treatment of constipation, the *cause must first be removed* if it can be discovered. The diet, digestion, and liver must be regulated, and sufficient muscular exercise, mental relaxation, and other hygienic provisions ensured.

Habitual constipation being generally referable to *torpidity of the muscular coat*, will be rationally treated by the administration of nervo-muscular stimulants. But these must be preceded by a free evacuation, since the tone of the intestinal wall cannot be restored until over-distension has been removed. For this purpose a more powerful purgative must be given at first, such as Colocynth and Blue Pill, followed by a saline, to thoroughly empty the gut; and this practice will be repeated with advantage every few weeks for a time. A regular course of aperient medicine may then be commenced. There is considerable choice of drugs which increase peristalsis, the best for habitual use being Aloes, Senna, Rhamnus Frangula, and Cascara Sagrada. Nux vomica (strychnia) is often added, in cases where the muscular tone has been lost by protracted overdistension; and Belladonna is a valuable adjuvant of Aloes in particular cases. Rhubarb, which is a popular aperient, is apt to produce further constipation.

Muscular torpidity is also rationally treated with cholagogues, and Rhubarb and Aloes act partly in this way. The saline cholagogues, such as Sulphate of Soda, and the many bitter mineral waters now sold (such as Friedrichshall and Hunyadi Jànos) are highly popular habitual purgatives, but are apt to lose their effect if given for a length of time, and then to increase rather than relieve constipation. In anæmic subjects the Pilula Aloes et Ferri, and in uterine inactivity the Pilula Aloes et Myrrhæ, are specially indicated. Purgative or simple enemata must occasionally be ordered, but the practice must not be continued lest it become habitual. It may be necessary to keep up the action of nervo-muscular intestinal stimulants for an indefinite period; and Senna is the best drug for this purpose, especially in the form of the compound Liquorice Powder.

Severe and protracted constipation, in which the bowels are heavily loaded with fæces, as in lead-poisoning or spinal paralysis, or as the result of indolent and careless habits, may demand a cathartic. The officinal preparations of Colocynth are suitable in such cases, containing as they do Aloes and Scammony, so that if they be followed by a saline draught, the entire length of the bowel will be evacuated. Sometimes even Croton Oil is required, and a large purgative enema may be preferable to repeated purgation by the mouth in weak subjects. This is an absolute rule in the constipation of typhoid fever.

The treatment of constipation constitutes but a small part of the use of purgatives. In a considerable proportion of the cases in which purgation is practised, the indication is to hasten or increase the natural activity of the bowels, in order to obtain some or all of the other effects of considerable evacuation, which we have already studied. The practical question then comes to be what degree of activity of purgation is desirable. The activity of a purgative may be estimated by the rapidity of its effect, by the number of the evacuations, by the amount of water in the stools, and by the degree of constitutional disturbance which it produces; these results, as a rule, varying directly with each other.

When there exists an urgent indication for the *reduction of the general blood pressure*, for instance, in cerebral hæmorrhage, with enlarged heart, the most active purgatives are employed. A drastic must then be given, such as Croton Oil, which has the further advantage of being very easily administered to an unconscious patient. When the portal system, heart, or systemic veins are overloaded, and the fluids of the blood are finding their way out of the vessels so as to constitute dropsy, *hydragogue cathartics and salines* are given, to establish a free flow of water from the bowel, and thus relieve the circulation. Jalap in the form of the Compound Powder, Colocynth, and—most powerful of all—Elaterium, are commonly employed, less frequently Scammony. Frequent saline draughts, either alone or after a purgative pill, have the same effect, such as the Sulphates of Soda and Magnesia, Cream of Tartar, and Rochelle salt.

At the commencement of inflammatory affections, for instance, acute bronchitis or local abscess, it is usual to unload the bowels and relieve the liver, heart, vascular tension, and respiration, by means of a *simple purgative*. The Colocynth and Hyoscyamus pill, with or without Calomel or Blue Pill, is well adapted for these cases, being given at night and followed in the morning by a Seidlitz powder.

Chronic congestion of the pelvic organs, bowels, and liver, a form of disorder not uncommon with sedentary persons, especially women, may call for a course of treatment by *aperient mineral waters*, usually containing Sulphates of Soda and Magnesia, at some watering place, or systematically at home.

Contra-indications and abuses of purgatives.— Purgatives must be used with special caution in delicate subjects, such as infants and the aged; in persons weakened by disease; in inflamed ulcerated conditions of the bowels; when there is a tendency to hæmorrhoids and other affections of the rectum; in pregnancy, and during menstruation. In such subjects and conditions, constipation should be relieved if possible by enemata or mild aperients, such as Castor Oil, Sulphur, Senna, and dietetic laxatives. Aged persons do not bear saline purgatives well unless they be given warm or combined with a carminative. The evil effects of the habitual use of purgatives has been already referred to.

Anthelmintics.—In connection with the remedies directed to the intestine, must be discussed the *anthelmintics* (*αντὶ*, against, and *ἕλμινς*, a worm), or medicines which expel or kill worms. These belong to two classes, namely (1) **vermifuges**, which simply expel the parasites (*vermis*, a worm, and *fugo*, I drive out); and (2) **vermicides**, which destroy them (*vermis*, a worm, and *cædo*, I kill). The vermifuges belong to the cathartic purgatives, such as Scammony and Jalap: they may be given either alone, combined with, or several hours after a dose of a vermicide. The principal vermicides are Male-Fern, Turpentine, Kamala, Kusso, Pomegranate Root, and Areca, Santonica and Santonin. The last named drugs act specially on the lumbicus, the others kill the tape-worm. The thread-worm (oxyuris) which infests the rectum is best reached by anthelmintic enemata of Turpentine, Aloes, or Salt and water, preceded by injections of a bitter infusion, such as Calumba or Quassia, with or without iron, to remove the mucus in which they flourish.

ANTHELMINTICS.

VERMIFUGES.	VERMICIDES.	INDIRECT ANTHELMINTICS.
Jalapa Scammonium Cambogia	Filix Mas Santoninum Ol. Terebinthinæ Kusso Spigelia Kamala Areca Granati Radix	Quassia Calumba Persalts of Iron Sodii Chloridum

SYNOPSIS OF SUBSTANCES WHICH ACT UPON THE INTESTINES.

DRASTICS.	SALINE PURGATIVES AND HYDRAGOGUE SALINES.	CATHARTICS AND HYDRAGOGUE CATHARTICS.	LAXATIVES OR APERIENTS.
Action.—*Chiefly cause catarrh of mucous membrane; increase glandular secretions and peristalsis.*	Action. — *Chiefly disturb osmosis; also stimulate the glands and increase peristalsis.*	Action. — *Chiefly increase glandular secretion, increase peristalsis, cause catarrh of mucous membrane.*	Action.—*Increase peristalsis moderately.*
Elaterium Croton oil Colocynth in excessive doses Gamboge Guaiacum	Potassæ Tartras Acida Potassæ Tartras Potassæ Sulphas Sodæ Sulphas Soda Tartarata Sodæ Citro-tartras Effervescens Sodæ Phosphas Sodii Chloridum Magnesiæ Sulphas	Mercurials Jalapa Scammonium Podophyllum Rhamnus Turpentine Tobacco Elaterium Colocynth	Oleum Ricini Senna Sulphur Manna Ficus Tamarindus Rhamnus Frangula Cascara Sagrada Rhamnus Catharticus Cassia Magnesia Magnesia Levis Magnesiæ Carbonas Magnesiæ Carbonas Levis Physostigma Ergota Belladonna Stramonium Hyoscyamus Sapo Taraxacum Ipecacuanha Mel Glycerinum Morus Oleum Olivæ Oleum Amygdalæ
		SIMPLE PURGATIVES.	
		Action.—*Increase peristalsis actively.*	
		Rheum Senna Aloes Small doses of drastics, cathartics, or salines. Fel Bovinum.	

Synopsis of Substances which Act upon the Intestines (*continued*).

Direct Cholagogues.	Indirect or Mercurial Cholagogues.	Intestinal Vascular Astringents.	Anti-Cholagogues.
Action.—*Stimulate liver.*	Action.—*Empty biliary passages, stimulate intestinal glands, and stimulate liver* (?)	Plumbi Acetas Argenti Nitras Acid. Sulphuric. Dilut. Acid. Nitric. Dilut. Acid. Acetic Dilut. Acid. Phosphoric. Dilut.	Opium Plumbi Acetas Intestinal irritants
Ammoniæ Phosphas Sodæ Phosphas Soda Tartarata Sodæ Sulphas Acidum Nitrohydrochloric. Dilutum Podophyllum Ipecacuanha Rheum Jalapa Scammonium Colchicum Colocynthis Aloes Acidum Benzoicum Euonymin Iridin Sodæ Salicylas Hydrargyri Perchloridum	Mercurials Cathartic Purgatives	Intestinal Constringents.	Adjuvants or Correctives.
	Intestinal Glandular Depressants.	Tannic Acid and all vegetable substances containing it Alum Persalts of Iron Zinci Oxidum Cupri Sulphas	Antimonium Piper Valeriana Nux Vomica Capsicum Hyoscyamus Belladonna Stramonium Cardamomum Zingiber Cannabis Indica Caryophyllum, Cajuput, and other Aromatics
	Opium (?) Belladonna Plumbi Acetas Calx Creta Alkalies indirectly through chyme Alkaline Earths indirectly through chyme	Nervo-Muscular Sedatives.	
		Opium Belladonna Hyoscyamus in last stage Plumbi Acetas Calx Creta Bismuthum; and Alkalies indirectly through chyme	

CHAPTER VII.

THE LIVER.

I. PHYSIOLOGICAL RELATIONS.

THE substances which enter the liver through the portal vein consist of the products of digestion in the widest sense, namely, proteids including leucin and tyrosin, sugars, salts, a trace of fat, and abundant water. When we parted with the proteids in the duodenum, they were in the form of peptones; when we meet with them again in the vena portæ, they have been transformed into ordinary serum albumen, apparently in the process of absorption. The sugars enter the liver partly unchanged, partly perhaps as derivatives—lactic and butyric acid. The proteids, sugars, water, salt, etc., will obviously be poured into the liver very abundantly during digestion. At the same time, there enters the liver through the hepatic artery a supply of oxygen which appears to be precariously limited, if we may judge by the size of the vessel. In the presence of this double supply, and in proportion to it, the hepatic cells display their special activity, and yield glycogen, urea, and bile. The urea and bile are carried off as such, the former by the hepatic veins to escape by the kidneys, the latter by the bowels. The glycogen has a less simple history. It accumulates in the liver cells, where it appears as a form of amyloid material specially adapted for storing up in an insoluble state the sugar and part of the proteids. By this arrangement the blood and body generally are saved from being flushed with sugar after each meal, and the sugar itself is not wasted. Under the influence of a ferment the glycogen is gradually re-converted into some kind of sugar; the amount of amyloid material hydrated varying with the necessities of the system. This function is regulated by a nervous mechanism, having its centre in the medulla, with efferent and (presumably) afferent nerves.

Another point in connection with the liver to be carefully noted by the therapeutist is *the circulation of the bile*. The bile, having entered the bowel and mixed with the chyme, is not entirely evacuated by the fæces. On the contrary, its most important constituents, the biliary salts, are re-absorbed from the bowel and carried back to the liver, again to be secreted and reach the bowel. Thus the bile may be said to move in a circle, comprised by the bile ducts and gall bladder, the intestine, and the portal vein.

II. PHARMACODYNAMICS.

Although the liver is apparently so inaccessible, we have great control over the influences under which its multiform activity is displayed.

(1) By means of the *food* we can completely interrupt the hepatic functions, or interfere with them at our pleasure. The amount of urea, the secretion of bile, the proportion of store glycogen in the liver, may be modified directly, within certain limits, by the amount of food allowed; and the urea and glycogen may be respectively made to vary with the relative proportion of nitrogenous and amylaceous constituents in the diet. The supply of oxygen which reaches the liver by means of bodily exercise, is equally under our control. The larger the volume of oxygen entering the liver, the more ready and complete will be the subtle processes of chemical composition and decomposition within it. We thus come to appreciate a fact of the first importance—that we can influence the liver through the medium of its *supply*. But we can do so in another way. We can tap, as it were, the channel of supply, the portal vein. The radicals of the portal vein in the rectum (superior hæmorrhoidal) anastomose with the veins around the anus, and leeches applied to this part will drain blood from the portal system, and thus indirectly from the liver. Closely allied to bleeding in principle is hydragogue purgation, which diverts a quantity of water from the portal radicles in the intestinal wall, and secures its evacuation.

(2) The liver may be influenced through its *products*, by securing the proper disposal of the urea, bile, and glycogen. In the bodily organs, as in the practical arts, the rate of manufacture cannot be maintained unless the products be removed. We have seen, in the stomach, that digestion is arrested by accumulation of peptones amongst the food. In the like manner, an accumulation of urea, of bile, or of glycogen, in the system, interferes with the hepatic processes. Now, as we shall afterwards see, we can increase the elimination of urea by the kidney, and thus indirectly stimulate the liver. On the same principle, the disposal of the bile furnishes us with a means of rousing the hepatic functions. This brings us to consider the action of indirect cholagogues.

That portion of the circulation of the bile which occurs in the intestine is thoroughly under our control. We can sweep the bowels empty of its contents; and with these the bile, which otherwise would have been re-absorbed, is expelled from the body. The portal blood and liver are thus deprived of material in which the biliary salts exist ready made, namely, their own products; and the hepatic cells are driven to fresh secretion. The purgatives which sweep away the old bile, and so lead to the production of new bile, are called **indirect cholagogues.** Mercurials specially act upon the liver in this way.

(3) We believe that we can modify the metabolic processes in the liver by **specific hepatic stimulants and depressants,** irrespective of both the supply and the products. Thus, Phosphorus, Antimony, and Arsenic, increase the metabolic activity of the liver, causing a greater production of urea, and the last two a free flow of bile. Bicarbonate of Soda and Dilute Nitrohydrochloric Acid have probably the same effect as regards the glycogen and the bile. Chloride of Ammonium remarkably increases the amount of urea, apparently by its own decomposition, but still probably through the agency of the liver cells. Iron increases the amount of urea. Amyl Nitrite stimulates the glycogenic function. On the other hand, there can be no question that the whole process of hepatic activity may be remarkably reduced by means of Opium, and to a less degree by Quinia and Alcohol.

The direct effect of certain drugs upon the secretion of bile is unquestionable. Podophyllin, Rhubarb, Aloes, Colocynth, Colchicum, Jalap, Scammony, Ipecacuanha, Sulphate of Soda, Phosphate of Soda, and Chloride of Ammonium, Nitrohydrochloric Acid, and (non-officinal) Euonymin and Iridin, stimulate the liver substance and increase the amount of bile secreted, and are therefore **direct cholagogues.** Mercurials, including Calomel, as well as acids and such substances as **Guaiacum, Sarsaparilla,** etc., possibly act less powerfully as direct hepatic stimulants. Opium and Morphia reduce the activity of the secretion.

III. PATHOLOGICAL RELATIONS.

The therapeutics of the liver will be best illustrated by a study of the treatment of its functional disorders. The common causes of derangement of the liver are to be found in the materials supplied to it, namely, food and air, and especially in the want of due proportion between the two. Most frequently there is excess of food—excess of rich food, especially of meat and alcoholic drinks, causing also primary indigestion. On the other hand, there may be imperfect oxygenation of the blood supplied through the hepatic artery, *i.e.* deficient respiration and circulation, generally referable to sedentary or luxurious habits, abstinence from muscular exercise, and confinement to ill-ventilated hot atmospheres. Not uncommonly the two classes of causes are combined, as is well seen in the disorders and diseases of the liver so common in the tropics.

Another way in which disorders of the liver originate is through retention of the products. If the kidneys, lungs, or bowels are inactive, the liver will be blocked, as it were, by urea, uric acid, sugar, and bile ; and hepatic metabolism will become feeble. This condition is generally referable to impaired muscular and circulatory activity; to want of exercise, air and light, which beget renal and intestinal torpidity: it is the disorder of town life. In other cases debility of the liver is distinctly inherited.

In whatever way induced, derangement of the liver consists in certain disturbances of the chemical processes within it, which manifest themselves by altered composition of the excretions and many well-marked symptoms. The urine contains an excess (rarely a deficiency) of urea, an excess of uric acid, occasionally sugar, and even albuminous bodies, derived probably from the liver; whilst its reaction is disturbed, the colouring matter is in excess, and leucin and tyrosin make their appearance in it. The bile is altered in quantity and quality, giving rise to diarrhœa or constipation with foul pale stools, to inspissation of bile in the ducts and gall bladder, and the formation of gall stones. The general symptoms of biliary disorder are referable to the circulation in the blood of an excessive amount of the normal products—urea, uric acid, etc., and of imperfectly formed products allied to these. Such products of disordered metabolism, though differing from the normal only by a few atoms, or in the arrangement of their atoms, may be highly deleterious in their action on the body. Entering the blood by the hepatic veins, they disturb the nervous system, and are the cause of the sleepiness, languor, irritability of temper, the headache, and the general misery and melancholy, so familiar in the "bilious." They enter the muscles and produce aching, weariness, muscular debility, and trembling. Palpitation and flushing indicate their action on the circulation, whilst the general nutrition also suffers. If this condition persist, certain chronic states of the system are induced, which are known as gout and lithæmia. The heart and vessels become diseased, as well as the skin and joints. Continued disturbance of the reaction and constitution of the urine leads to a deposit in the urinary passages of some of its salts in a solid form, constituting gravel or calculus ; and structural disease of the kidneys may ultimately result.

Absorption of bile into the blood may occur in these cases, but more so in actual plugging of the ducts, which leads to *jaundice*. In either case, some or all of the constituents of the bile enter the blood, circulate with it, colour all the organs, and are cast out in the various secretions, especially the urine.

Lastly, the glycogenic function of the liver may be disordered, and sugar make its appearance in the blood, urine, and all the tissues, constituting glycosuria or diabetes mellitus. Excess of sugar-yielding food may cause this, as we have seen, but well-marked diabetes is generally referable to derangement of the elaborate nervous and chemical processes of storing and re-distributing the nutrient elements of the food carried on in the liver. Hunger and wasting are therefore its prominent symptoms, and thirst is also very urgent from the diuretic effect of the sugar. In some instances diabetes may be traced to injury or disease of the hepatic ("diabetic") centre in the brain, or of the nervous connections between it and the liver.

IV. NATURAL RECOVERY.

Disorder of the liver disappears under favourable circumstances; that is, with a return to the normal influences. Recovery is assisted, on the one hand, by temporary abstinence from food, brought about by loss of appetite, or even loathing for food; and, on the other hand, by excretion of the morbid products. Excess of bile relieves itself naturally by bilious diarrhœa. Nature requires guidance, however, in hepatic disorders, for the languor, depression, and muscular debility which it originates tend to give rise to further indisposition to exercise, and thus to an aggravation of the evil.

V. THERAPEUTICS.

Hepatic disorder can only be *prevented* by taking a comprehensive view of the relation of the liver to the organs of digestion, absorption, blood-formation, and excretion. The income in the way of food and air must be thoroughly supervised. The diet must be definitely ordered. Perfect digestion and intestinal activity must be secured. In many cases it is found that when this has been done, little more is required. Abundant bodily exercise must be recommended. The atmosphere breathed must be as pure, cool, and bright as possible. Sedentary or lazy habits must be changed for wholesome exercise in the open air, in the form of walking or riding. In the class of cases of disordered liver constantly met with in large towns, change is essential from the foul hot dull atmosphere of the workshop and dwelling, to the pure air of the parks or of the country. But the beneficial effect of exercise on the liver is not to be estimated solely by the amount of oxygen admitted. It will also be evident in increased activity of the kidneys, skin, and bowels, all of which will unburden the liver by hastening the removal from the blood of metabolic products.

If prophylaxis fail, and disorder be actually present, *immediate treatment* must be undertaken. The first step will be to remove, if possible, the causes of the disorder. A careful inquiry into the habits and constitution will often reveal serious errors in the mode of living. These must be reformed as has just been suggested. Active medicinal treatment must be begun at the same time; and in arranging the details of this, several objects may be combined. A brisk purge must first be employed, so as to sweep the intestine of imperfectly digested food, and stimulate its absorptive, excretory, and locomotive functions. The question of the selection of a purgative introduces us to the use of cholagogues. Calomel and Colocynth, Rhubarb and Colocynth, Podophyllin, and a variety of allied purgatives and cholagogues, mentioned in the second section, in proper combination with carminatives, are in constant employment for increasing the flow of bile. An almost invariable practice is to follow up the purgative by a saline, and the rationale of this plan is obvious. The Sulphate of Magnesia, Sulphate of Soda, or Tartrate of Potash and Soda with Tartrate of Soda (Seidlitz powder), not only complete the evacuation and stimulation of the bowel and the cholagogue effect, but their hydragogue influence (with that of the previous purgative), will drain a certain amount of water from the portal vein, and thus relieve the circulation within the liver. At the same time some of the salts will be absorbed into the blood and excreted by the kidney, which, as we shall afterwards see, they powerfully stimulate, thus opening the second great channel of relief to the liver—the urinary discharge. The tartrates pass out in the urine as alkaline carbonates, and by this means the excess of uric acid which may have threatened or had actually produced gravel, is neutralised and safely conducted from the body. Altogether the time-honoured Blue Pill and Seidlitz powder are a combination which is in every respect scientifically sound, although probably of purely empirical origin. In urgent cases of acute hepatic disorder, the therapeutist may even divert part of the blood-supply by tapping the portal vein, that is, by applying leeches round the anus.

An attempt may next be made to act upon the liver *directly*: to rouse its metabolic energy by one of the specific agents already enumerated. Perhaps the best of these in acute hepatic disorder is Bicarbonate of Soda, given between meals in some of the combinations suggested in chapter iii., especially with Rhubarb, Senna, or Aloes. In more chronic cases, Chloride of Ammonium or Arsenic often proves of great service given immediately after meals, or that valuable combination of hepatic stimulants, the Pilula Hydrargyri Subchloridi Composita, given every night for a week on end. In cases of chronic hepatic disorder originating in the tropics, Diluted Nitrohydrochloric Acid is often used with success both internally and as a bath. The effects of hepatic disorder upon other parts of the system frequently demand direct relief, such as the headache, languor, or mental depression. Alcohol will frequently answer the purpose, but induces further hepatic disorders, and is otherwise obviously objectionable. The same remarks apply to Opium, except in very small doses "to take the edge off the misery." Quinia given after meals is of unquestionable service in many instances. Tea and coffee are useful and safe remedies. But on the whole too much reliance must not be placed on treating symptoms.

For the treatment of that remarkable disorder of hepatic metabolism which is called diabetes mellitus, the complete rearrangement of the diet is the first requisite, by the removal of amyloid and saccharine substances from the food. Nothing in the whole range of therapeutics is more striking in its way than the effect of Opium, Morphia, or Codeia in dispelling the last trace of sugar from the urine in such cases, the quantity of the drug tolerated being sometimes enormous.

Substances which act upon the Liver.

Direct Cholagogues.	Direct Cholagogues. — (*Cont.*)	Glycogenic Stimulants.	Substances Increasing Urea.
Antimonium Sulphuratum Acidum Arseniosum Dilutum Acidum Nitricum Acidum Nitrohydro. Dil. Hydrarg Perchlor Soda Salts Ipecacuanha Colocynthis Podophyllum Sodæ Salicylus Ammoniæ Phosphas Euonymin Iridin Aloes Colchicum Jalapa Scammonium.	Rheum Acidum Benzoicum	Amyl Nitris Sodæ Bicarbonas Acidum Nitrohydrochloricum Dilutum	Antimonium Phosphorus Acidum Arseniosum Ammonii Chloridum Ferrum
	Indirect Cholagogues.	Glycogenic Depressants.	Substances Diminishing Urea.
	Hydrargyrum Cathartic Purgatives	Acidum Arseniosum Opium Morphia Codeia	Opium Morphia Colchicum Alcohol Quinia
	Anticholagogues.		
	Opium Morphia Plumbi Acetas Intestinal Irritants		

CHAPTER VIII.

THE BLOOD.

WE will now suppose that the products of absorption and hepatic metabolism have entered the blood. The peculiar relations which the blood bears to the solid organs gives a special character to its pathology and therapeutics. It possesses of itself no active functions, but is simply a great fluid medium which conveys nutrient material and oxygen to the tissues, and carries away the products of their activity. In the same way it is the medium by which the active principles of drugs reach the internal organs, without, as a rule, materially disturbing the functions of the blood itself. It is not surprising that the blood should have comparatively few primary disorders, whilst it is constantly liable to suffer in consequence of disease of the digestive organs from which we have traced its supply, and of the excreting organs by which its constituents finally leave the body.

I. PHYSIOLOGICAL RELATIONS.

The physiological relations of the *liquor sanguinis* are very obvious: it is the medium of nutrition. It carries between the different organs the materials which are the sources of energy, namely albumins, fats, sugar, water, and salts, as well as the products of the vital processes—carbonic acid, water, urea, salts, and other substances. It possesses a mean volume, an alkaline reaction depending on the presence chiefly of salts of soda, and a certain general uniformity of composition, which, however, varies considerably at different parts of the circulation—for instance, before and after exposure of the blood to the liver, lungs, muscles, or other active organs. The composition of the liquor sanguinis is indeed the balance of two opposed processes—a process of supply, income, or ingestion, which we have traced through the liver from the food; and a process of production, expenditure, or egestion, carried on by the active organs of the body, with their measurable products, energy and excretions. The *white corpuscles* are physiologically associated with the plasma, that is, are essentially nutritive, in function; but are probably also the source of the red corpuscles.

The function of the *red corpuscles* is perfectly distinct from the functions of the plasma. They are the great medium of respiration, carrying oxygen from the lungs to the tissues, and are thus the respiratory elements of the body. It is important for the therapeutist to remember that the red corpuscles consist chiefly of *hæmoglobin*, with a small quantity of salts, which have *potassium* as their principal base united with *phosphoric acid.* Iron is an essential component of hæmoglobin ($C_{600}H_{960}N_{154}FeS_3O_{179}$). Whatever may be the immediate source of the red corpuscles, there can be no doubt that the most important factors in their development are food, air, and free exposure of the blood to light. Ultimately they are broken up, their products forming the colouring matters of the various secretions.

II. PHARMACODYNAMICS.

1. Our power over the blood plasma in health is easily appreciated. The most obvious means of influencing it is through the *income* or supply. We can alter a man's diet, his digestion, and his hepatic functions, and by these indirect means we retain a hold on the vital fluid. We can also modify its several constituents during their ingestion—the albumen, sugar, water, phosphates, carbonates, chlorides, sulphates, etc.—by regulating the food or administering them in the form of drugs. A fact of great therapeutical importance is that we can *increase, within certain limits, the alkalinity* of the plasma by means of alkalies or alkaline earths, given as the Bicarbonates of Potash or Soda, as the various solutions of these or of Lithia, Lime, and Magnesia; or in a more moderate degree over a longer period, by means of the many natural alkaline waters, such as those of Vichy, Carlsbad, Baden Baden, Ems, and Bilin. **Alkalinisers of the blood** act upon the plasma not only directly, but indirectly by combining with uric acid, and carrying it with them out of the system by virtue of their diuretic influence. Potash is the most rapid and evanescent alkaliniser; Soda is slower and more permanent, as is fully described in Part I. The citrates and tartrates are also alkalinisers of the blood, being decomposed, as we shall presently see, in the presence of the red corpuscles, into alkaline carbonates. It is much more difficult to *reduce the natural alkalinity* of the blood. Mineral Acids have very little effect in this direction, as they enter the blood in the form of neutral salts of potash, soda, etc., which pass out undecomposed. Citric and Tartaric Acids remain partly unchanged in the plasma, and Benzoic, Cinnamic, and Salicylic Acids also pass through it, the two first being partly converted into hippuric acid. Free Iodine may be temporarily liberated in the plasma from the iodides.

Besides these, most of the materiæ medicæ enter the system through the plasma, where they exist in every possible form, whether unchanged, or as albuminates, chlorides, sulphates, etc., or as highly complex compounds. It is most important, however, for the student to observe that, beyond the alkalies and acids, but few drugs act upon the plasma. The great majority of them simply exist in it, and are conveyed by it to the tissues and organs of elimination, where they exert their specific influence.

But we may go beyond this, and alter the total amount of blood or plasma in the body by actually adding to it from the blood of another person or animal. This is done by *transfusion*, a powerful means of restoring the blood, but one which is not always readily available.

2. We can affect the value of the plasma through the *expenditure* or egesta. We have seen that purgation is a ready means of influencing the water, salts, albumen, and other constituents of the plasma in the portal system, and thus in the blood generally. We shall find in subsequent chapters that in the same way we can stimulate excretion by the kidneys and by the skin. We shall also discover, under the head of metabolism, that we can so far either tax or spare the great organs which are the source of vital energy and therefore of waste, such as the muscles, and thus the metabolic and nutritive value of the whole blood. But we can go much farther than this: we can actually *abstract* a certain quantity of blood by venesection, cupping, or leeching, as we have already seen in the case of the portal vein; and such alteration in quantity will cause a decided alteration in quality, for, as we shall find in chapter x., abstraction of blood increases the amount of water in the plasma.

3. A small number of drugs are known to act directly upon the *white corpuscles*. Quinia reduces their number, and paralyses their movements; Veratria kills them (out of the body). All aromatic oils, resins, and gum-resins, especially Myrrh, are believed to increase their production.

4. We can increase the richness of the blood in *red corpuscles*, and the richness of the individual corpuscles in hæmoglobin, by giving abundant digestible and assimilable food, and by securing the activity of the lacteal tract, which is concerned in their production. Fresh air and sunlight can be secured by change of habits or residence. We can also increase the constituents of the red corpuscles admitted into the system. Iron, which the pharmacopœia provides in so many forms, directly increases the amount of hæmoglobin even in healthy individuals. Carbonate of Potash, in proper combination with Iron, as in the Mistura Ferri Composia or Blaud's pill, unquestionably increases its value. Phosphoric Acid, whether as the Diluted Acid or as the Phosphate of Iron and other bases, is also a reputed blood-restorer. All

these substances, and such others as indirectly improve the quantity and quality of the hæmoglobin, are known as **hæmatinics.**

Arsenic, Phosphorus, and perhaps other metals combine with the hæmoglobin, partially reduce it, or otherwise interfere with its constitution or quantity, so as to impair the oxygenating power of the corpuscles if given in full doses. Citrates and Tartrates have a peculiar deoxidising effect on the blood, being converted in part into carbonates at the expense of the hæmoglobin, thus, $2K_3C_6H_5O_7 + O_{18}$ (from hæmoglobin) $= 3K_2CO_3 + 9CO_2 + 5H_2O$. Lead reduces the number of the red corpuscles, but probably indirectly, by interfering with digestion. Iodine and Sulphur (Sulphides), Turpentine, and a few other drugs, such as Diluted Hydrocyanic Acid, reduce the oxy-hæmoglobin of the corpuscles, but only after excessive doses, so that in this respect they may be regarded not as drugs, but as poisons, and will be noticed in the next section. The Nitrites of Amyl and Soda, and Spiritus Ætheris Nitrosi convert part of the hæmoglobin into met-hæmoglobin, but only when given in excess. On the other hand, Alcohol and Quinia bind the oxygen more firmly to the corpuscles, and thus reduce oxygenation. Nitrous Oxide gas acts indirectly on the corpuscles by taking the place of oxygen, but does not chemically combine with the hæmoglobin. It is manifest that the methods of venesection and transfusion will influence the corpuscles as well as the plasma.

III. PATHOLOGICAL RELATIONS.

As was mentioned in the introduction, the morbid conditions of the *plasma* are chiefly secondary; that is, caused by disorder either of the organs from which it draws its supply—the digestive organs and liver, or of those by which its products leave the body, especially the lungs and kidneys.

Thus excess of blood, which constitutes one kind of plethora, is referable to indulgence in food, combined with lazy habits. The opposite condition, anæmia, or deficiency of blood, is a very common disorder, which may arise from an endless variety of causes, whether of the nature of want (insufficient food or imperfect digestion) or of waste (excessive work, growth, exhausting diseases, or hæmorrhage). The constituents of the plasma are no doubt often disordered, but this subject is still obscure. The albumins are deficient in anæmia. Carbonic acid increases in respiratory difficulty. The water of the blood is increased in anæmia; greatly diminished in cholera, where its excretion is excessive. The alkalinity of the plasma is believed to be reduced in rheumatism, from some unknown cause. Uric acid is certainly in excess in gout. In calculous subjects there is apparently some obscure tendency to disturbance of the reaction of the blood, referable to derangement of primary and secondary digestion. Sugar is in excess in diabetes, probably from disordered supply ; urea is in excess in Bright's disease, from defective excretion. The *white corpuscles* are liable to abnormal increase, as in leukæmia, but it is still doubtful whether these are instances of primary disease of the blood.

The diseases of the *red corpuscles* are certainly few and imperfectly known; practically they may be represented as deficiency, and deoxydation or reduction of hæmoglobin. *Deficiency* of hæmoglobin, whether traceable to want of blood as a whole, to poverty of the blood in *red corpuscles*, or to deficiency of the individual corpuscles in hæmoglobin, reduces the oxygenating value of the vital fluid. All the bodily functions become feeble : the patient is weak, dull, sleepy, and suffers from every possible functional derangement, especially shortness of breath.

Reduction of hæmoglobin, or, more correctly, of oxyhæmoglobin, is a result of the admission to the blood, in poisonous quantities, of certain substances which we have already mentioned, such as Phosphorus, Arsenic, or Turpentine in poisonous doses. Carbonic Oxide enters into combination with the hæmoglobin, whilst the oxygen is expelled from the corpuscles. Hydrocyanic Acid unites partly with oxyhæmoglobin, partly with reduced hæmoglobin. Other bodies, such as Sulphuretted Hydrogen, seize upon and combine with the oxygen, leaving the reduced hæmoglobin to be dissolved out of the corpuscles and diffused through the blood. Either of these conditions is highly dangerous, the new hæmoglobin compound in the first case being with difficulty replaced by oxyhæmoglobin; whilst the reduction and solution in the second case are incompatible with life if they have occurred to any extent.

IV. NATURAL RECOVERY.

The quantity and functional value of the liquor sanguinis, being but the balance between the income and output of the body, readily return to the normal after disturbance. The same is true of the corpuscles. As long as the disorders of the red corpuscles are of a purely quantitative kind, the restoration of the normal conditions is followed by a return of the blood-elements to their proper constitution. The natural means of recovery are to be found in the shortness of breath and debility which accompanies anæmia, and which compel the patient to spare the blood every possible source of waste; at the same time the increased frequency of the pulse and breathing compensate for want of hæmoglobin. Unfortunately there is here as elsewhere a limit to recovery, as when large quantities of a poison, such as carbonic acid, have entered the blood, or when the hæmoglobin has been reduced.

V. THERAPEUTICS.

The facts which we have reviewed under the four preceding heads are highly encouraging to the practical therapeutist.

In *plethora* he will reduce the amount of food, increase the excretions, and prescribe increased bodily exertion; five-and-forty years ago he would have bled the patient freely, and repeated the operation at regular intervals.

Anæmia must be treated by the opposite class of measures, which will be discussed immediately under the head of the red corpuscles. Speaking generally, we must sustain and restore the appetite and digestion, spare the body every possible exertion, maintain healthy excretion, and, if the condition be urgent, even transfuse blood into the veins. Deficiency of albumen is met by the same measures. Excess of carbonic acid demands artificial respiration, as we shall find under respiratory diseases.

When the indication is to *increase the alkalinity* of the plasma in rheumatism, gout, and allied morbid states, we administer salts of Potash, Soda, Ammonia, Lithia, or the Alkaline Earths, the Alkaline Citrates and Tartrates being the most suitable because large quantities can be admitted into the blood without deranging digestion. Acids, which have so little influence in the opposite direction, are fortunately seldom called for. The treatment of poisons in the blood, whether formed in the body or introduced from without, will rationally consist first in removing their cause, *e.g.* indigestion or renal disorder, or in decomposing or neutralising them chemically. This introduces us to the second use of alkalies in the blood. The acid of rheumatism, whatever it may be, and the uric acid of gout, are converted into soluble salts by the Alkalies and Alkaline Earths, and these salts are fortunately diuretic. In this way excess of acid is not only neutralised, but conveyed out of the system, and the reaction of the urine may be used as a test of the success of our action on the blood. This end is secured in acute cases by the free exhibition of the milder salts of Potash, Soda, Ammonia, and Lithia; in chronic cases by treatment at an alkaline bath, such as Ems, Homburg, Vichy, Carlsbad, Buxton, or Bath. Metallic poisons, such as lead, are removed from the blood and tissues in precisely the same way; lead, for example, by Iodide of Potassium or Sulphur baths.

Poisons may also be removed from the blood by simple increase of the excretions—carbonic acid through the lungs by artificial respiration; urea by diuresis, free purgation, and diaphoresis; and so with the products of indigestion, which is relieved by a cathartic pill and a saline draught.

If the *hæmoglobin be deficient*, we must secure a sufficient supply of digestible and nutritious food, pure air, and direct sunlight; reduce the amount of work, by ordering rest or even confining the patient to bed; and attend to all the functions which are connected with the formation, growth, and purification of the blood. Correction of derangements of the stomach and bowels always demands special attention, and is a *sine quâ non* for success. At the same time, any actual waste of the blood must be arrested, if possible. Passive hæmorrhages must be checked. Growth and development may be rendered less trying by directing the blood to parts where it is specially required; for instance, to the uterus by means of emmenagogues. We must next hasten to restore the red corpuscles by supplying their important chemical elements—Iron, Phosphoric Acid, and Potash. Long before the composition of hæmoglobin was understood, it had been empirically discovered that Iron was a certain remedy for "want of blood." This is our daily experience still; science in this instance has confirmed and not suggested practice. Iron has other actions and uses therapeutically, but its chief employment is as a hæmatinic. The particular form in which the metal may be administered is discussed under its own head, but one or two combinations with iron must be noticed here. The Mistura Ferri Composita, an old-established empirical combination of Protosulphate of Iron, Carbonate of Potash, Myrrh, and Aromatics; the Pilula Ferri et Aloes; and the non-officinal pill of Blaud, containing Protosulphate of Iron and Carbonate of Potash, are specially successful remedies in anæmia, the rationale of which will now be obvious to the student. The Phosphate of Iron is also indicated, and is highly successful in some instances. Altogether, the medicinal treatment of deficiency of hæmoglobin practically resolves itself into the continuous administration of iron in some useful form or combination, without impairing digestion or the action of the bowels.

In urgent cases of want of blood corpuscles, whether acutely developed by hæmorrhage, or progressing slowly to an extreme degree, transfusion must be practised.

Reduction of oxyhæmoglobin defies therapeutical measures if it have advanced beyond the very first stage, that is, the treatment of poisoning by carbonic oxide, prussic acid, etc., is rarely successful. It must, however, be attempted. Combined venesection and transfusion would theoretically be the proper treatment—to remove disorganised blood and poison, and to replace them by healthy corpuscles and plasma. But this is manifestly very rarely practicable. All that can be done, as a rule, is to sustain the circulation and respiration, by general stimulants and artificial respiration, and thus preserve vitality by means of the oxygen and hæmoglobin that may still remain active. In every case it will be proper to do this until transfusion can be undertaken.

SYNOPSIS OF SUBSTANCES WHICH ACT ON THE BLOOD.

SUBSTANCES WHICH ACT ON, OR ARE DECOMPOSED IN THE PLASMA.	SUBSTANCES WHICH ACT ON THE WHITE CORPUSCLES.	SUBSTANCES WHICH ACT ON THE RED CORPUSCLES.
Potassi Iodidum Sulphur (Hydrosulphuric Acid) Benzoin, Acidum, Benzoic Styrax Salicylates Oleum Olivæ Oleum Morrhuæ Succus Limonis Potassium Sodium Lithium Calcium Magnesium Acids	Quinia Veratria Myrrha Aromatics	Iodides Sulphur (Hydrosulphuric Acid) Quinia Alcohol Sodium Nitrite Spiritus Ætheris Nitrosi Acidum Hydrocyanicum Dilutum Oleum Terebinthinæ Potassium Ferrum Arseniosum Phosphorus Tartaric and Citric Acids

CHAPTER IX.

METABOLISM—THE ACTION OF MEDICINES—ALTERATIVES.

WE now pass on to consider the process of nutrition or metabolism, that is, the activity of the tissues, the development of force by protoplasm in the presence of blood. We shall find that this subject has an important bearing on the action and uses of many drugs and other therapeutic measures.

I. PHYSIOLOGICAL RELATIONS.

The best means of comprehending the obscure subject of metabolism is to take the instance of a muscle. A muscle has a definite structure; enjoys a free supply of blood; displays force during the period of its contraction, namely, mechanical energy, heat, and sound; and produces certain chemical substances—carbonic acid, water, sarkolactic acid, kreatin, other allied nitrogenous bodies, and possibly urea. The blood which passes through the muscle becomes venous, that is, loses oxygen and a small quantity of proteids, and takes up the waste products.

In doing this work, the muscle first incorporates the oxygen and other elements of the plasma with its own substance, however loose that combination may be. In this respect the molecules of the muscle are being constantly changed. It is a fact of the first importance to the pharmacologist, that when a muscle or any other living tissue incorporates nutrient materials, acts upon them, and forms force and other products from them, its own molecules are changed or altered. As the blood or plasma supplied varies, so will the materials vary that are incorporated, the amount and even the character of the force and the products, and the chemical—possibly even the anatomical—constitution of the active protoplasm. In one sentence, we may say that the muscle and the plasma act and re-act upon each other: that the protoplasm *acts on* or *alters* the lymph; the lymph *acts on* or *alters* the protoplasm.

This process of double decomposition appears to be going on in every organ and tissue of the body; though, naturally, the tissue being different in each case, so are the particular substances broken up by it, the products yielded by it, and the particular kind of force which it displays, for instance secretion, nervous energy, growth and development. The oxygen and the proteids are carried to the organs by the arterial blood; the heat is distributed and lost; the carbonic acid, water, and nitrogenous and other products are excreted by the lungs, skin, kidneys, and bowels; and the active organs are maintained in size and vigour amidst all the change.

There are various *means of estimating* the state of metabolism in the living body. We may measure, first, the amount of *force displayed*—the muscular activity or *tone*, the rate of growth, the temperature, the mental capacity; or, secondly, the amount of *material consumed*—the food taken and the air inspired; or, thirdly, the *products* of metabolism, that is, the excretions. The first two means are by no means always available with accuracy. This is what makes the examination of the urine, the principal excretion, so important in the majority of clinical cases; for knowing the state of the urine, we can work backwards, as it were, and estimate the functional activity and even the anatomical state of the organs in which its constituents have been produced.

Unfortunately, metabolism is not the simple process which we have described, but in many respects still very obscure. Thus the proteids are not at once broken down into carbonic acid, water, and nitrogenous compounds, as represented above. In some of the tissues at least there are intermediate products, one of which is fat, which is in turn oxydised into carbonic acid and water. It is also probable that all metabolism is associated with ferments, if not actually due to their activity, like digestion and the coagulation of the blood. Lastly, the intimate protoplasmic changes which are the basis of vital force are controlled by the central nervous system, by *trophic* centres lying in the cord and cerebrum, with afferent and efferent trophic nerves.

II. PHARMACODYNAMICS.

This brings us to the second part of our inquiry—our power over metabolism in a healthy individual. This is greater than would at first appear.

1. Our influence on metabolism through *the blood as a whole*, has been fully discussed in the preceding chapter, and does not require to be more than mentioned here.

2. We can affect nutrition through the *constituents* of the blood which supply material to the particular organs. Experience taught us, long before science, how to feed a man in training for muscular exertion; which kinds of food are specially suited for the exercise of the brain, for the periods of growth and development, of pregnancy and lactation, of degeneration and decay. It is but expressing the same fact in other words to say that by supplying an excess of certain kinds of food, we can increase the activity of an organ, the cells of which appear to exercise themselves more vigorously when their natural source of energy and nutrition is freely supplied to them. Alcohol, Cod-liver Oil, Olive and Almond Oils are thus valuable foods, or **nutritive tonics.**

3. An increased supply of *oxygen* in the blood increases metabolism. The valuable influence of fresh air on active organs is familiar, and we have learned in this connection the use of Iron, which is thus a **hæmatinic tonic.**

4. An increased amount of work is an interesting means of increasing protoplasmic activity. By throwing more weight upon a muscle, up to a certain point, we can increase the force of its contraction. This is *exercise;* but it must be accompanied by a sufficient supply of plasma and oxygen. A man in training not only selects his food and air, but throws an increased amount of work on his muscles by exercising them regularly.

5. We can influence metabolism by means of the *excretions*, that is, by hastening the removal of its products through the lungs, kidneys, skin, and bowels, as we have already seen in the case of the stomach and liver. The same principle manifestly applies to all the tissues.

6. The *trophic* centres are amenable to impressions carried in by their afferent fibres, and such of these fibres as originate in the surface of the body are thoroughly accessible, and ready to convey any influence which we may impress upon them, such as extremes of heat and cold, by means of the cold bath or douche, stimulation by Mustard or Cantharides, and the direct battery current.

7. The metabolic activity of a part may be increased by certain local measures which are familiar to us, as friction and shampooing. The physiological effects of these **local alteratives** or **local tonics** are very powerful. Their action is complex, partly direct and partly reflex through the trophic nerves. They cause, first, dilatation of the local vessels, leading to increased circulation in the tissues; more rapid removal of the products of nutrition by the lymphatics and veins; and an actual exercise of the tissue elements, *e.g.* of the muscles, by well-arranged movements. No doubt these effects can be increased by the use of certain local circulatory stimulants, in the form of liniments of Ammonia, Alcohol, Chloroform, and the great group of Volatile Oils of the Turpentine and Camphor series. But, further, these local alteratives and tonics react upon nutrition generally, probably through the nervous system, and greatly stimulate it, improving the appetite and digestion, and rapidly causing an increase in the strength and the weight of the body, and thus become **general tonics.** The action of poultices, blisters, some forms of electricity, and other local applications, on the nutrition of deeper parts, which is known as *counter-irritation*, is discussed in chapter XV.

8. The surrounding *temperature* has a powerful effect upon nutrition. Heat and cold are universally recognised as being stimulating, enervating, relaxing, tonic or bracing, as the case may be. Water, in every form, from vapour to solid ice, is a convenient means of bringing any temperature that may be desired into contact with the tissues, whether directly or indirectly through the vessels and nerves. In other words, we possess, and have greatly elaborated, the means of affecting nutrition by baths and climate, the actions and uses of which are the subjects of **balneology** and **climatology.**

9. *Medicines.*—We have made a further important discovery with respect to our influence over metabolism—that we can admit to the organs other than the normal constituents of the

blood, and allow them to participate in the vital processes. Thus, if such foreign substances as Mercury or Arsenic be introduced into the blood, the muscular and other tissues will take them into their substance, just as they take up proteids, salts of lime, and water, and incorporate them in a loose chemical way, their own proper composition being essentially unaltered. By whatever channel they may be introduced into the blood, most of the active principles of the materia medica are carried in the plasma to the tissues and organs, and are said to "act upon" or to "have a specific action" upon them. Thus, Iodine acts upon the glands, Bromine upon the brain, Potash on the heart, and so on. By this expression we mean that the medicines having reached an organ take part in the process of metabolism; that they become loosely incorporated with the anatomical elements of the part; that they form, either in these, or in the presence of these, certain chemical compounds with oxygen, different from the ordinary; that they are cast out again in the metabolic products, either unchanged or in a new chemical form; and that, *in thus passing through the organ and taking part in its activity, they have modified the force which it displays.* Thus, Alcohol, in passing into muscle, becomes oxydised and converted into carbonic acid and water, and in the process of decomposition increases the force of muscular contraction. Alcohol is accordingly said to act specifically upon muscles. So with all tissues and organs: some incorporate from the blood one substance, some another. Just as the life-processes of the various tissues and organs differ from each other, so will some select or be acted on by some principles, others by other principles. Gland protoplasm is acted upon by Iodine, nervous protoplasm by Bromine, muscle protoplasm by Potash, red corpuscle protoplasm by Iron, and so on.

Here it is necessary to offer a word of caution. The expression "action" of a medicine is generally used in a much wider sense than that just indicated. When we say that a given therapeutical substance acts upon "an organ," we do not always mean that it acts upon the *protoplasm* of that organ. When we say that alcohol acts upon the skin, flushing it and increasing its heat and secretion, we do not imply that alcohol is decomposed by the connective tissue-cells of the skin. An organ possesses not only active protoplasmic cells but vessels and nerves; and a vast number of the effects of drugs upon organs are due, as we shall see in subsequent chapters, to their action upon the vessels and the nerves that supply these organs. Ultimately, of course, all drugs do act upon protoplasm in some form, on the protoplasm of muscular tissue, of nerve-ganglia, of the walls of blood-vessels, or of the cells of the nerve-centres which regulate the vessels. But for practical purposes it is highly important to keep the action of drugs upon the protoplasm of an organ quite distinct from their action upon the organ through its nerves or its blood supply.

Alteratives.—The subject of metabolism introduces us to a term applied to certain drugs, namely, **alteratives.** This word, like many other terms in therapeutics, never had an exact application, and therefore defies correct definition. Still, it is retained as a useful word, and its meaning may be discussed if it cannot be defined. We have seen that we can increase the amount of work done by an organ in several ways, through food, air, local stimulation, etc., which make it build up and break down more actively both its pabulum, the lymph, and its own proper elements: which, in one word, *exercise* it. Certain medicinal substances also are found to **increase metabolism,** the chief of which are Mercury and Iodine, Phosphorus, Antimony, and Arsenic, Sulphur or Sulphides, and certain doubtful vegetable agents, such as Sarsa and Guaiacum. The particular way in which each of these drugs increases tissue waste is given under its own head, as far as it is known. It naturally occurs to us, that the action of these medicines is another form of exercise of the tissues. When Mercury and Iodine, for example, have entered into combination with living protoplasm, and been again disengaged or thrown out of combination with it in the metabolic products, they have *made it do a certain amount of work:* and to a corresponding extent they have effected a change and a renewal of its proper molecules; they have hastened its nutrition; their action may be said to be *alterative.* We find that an essential condition of the success of alterative drugs is a free supply of the normal sources of metabolism, food and air, just as it is of physical exercise, that the constructive part may keep pace with the destructive part of metabolism. If food and air fail, the health rapidly breaks down, the body wastes, and death may result. Possessing a powerful and peculiar action like this, these medicinal agents fully deserve the name of alteratives, and any method of treatment which may be founded upon their action is incomplete unless it include abundant feeding and fresh air.

Opposed to the alteratives are an important class of drugs which **diminish metabolism.** Alcohol has this action, apparently by being itself so readily oxydised in the tissues that it robs the cells, as it were, of oxygen, while it also binds the oxygen more firmly to the red corpuscles, and thus in two different ways spares tissue change. Quinia also lowers oxygenation, and has a further influence in preventing oxydation of protoplasm, which is imperfectly understood. Probably

Alcohol, Quinia, Resorcin, Kairin, Chinolin, and Salicin, also diminish the activity of the natural metabolic ferments.

Complex Measures.—Some of the most powerful means at our disposal for influencing nutrition are a combination of the preceding measures. The best illustration of this is the treatment carried on at a foreign bath, we shall say at Aix-les-Bains, in Savoy. Here an English patient enters a new, a purer, and a warmer atmosphere. His food is reduced in quantity and changed in quality; he has to take active muscular exercise; he enjoys a daily bath, which is really a complex arrangement of washing, rubbing, douching, and frequent change of surface temperature; and he has to drink a definite amount of the waters, which contain Soda, Lime, Magnesia, Iron, and Iodine. Such a combination of measures is manifestly powerfully alterative.

Tonics, which increase the tone or general muscular and nutritive vigour, belong, as we have seen, to several of the preceding classes.

III. PATHOLOGICAL RELATIONS.

The disorders of metabolism are many and complex. Diseases so wide apart as gout, syphilis, and malaria, and disorders so different in their cause and effects as fever and fatty degeneration, are linked together by the fact that they are all affections of nutrition. In this place we can refer but to a few of them, and that very briefly.

The cause of metabolic disorder is most frequently found in the *ingesta*. An *excessive* supply of lymph to the active cells, an unnatural richness of the blood in proteids from indulgence in food, or an insufficient supply of oxygen from insufficient exercise, will disturb general metabolism as they disturb hepatic metabolism, and contribute to the production of the diseases known as obesity and gout. *Deficiency* of plasma is a result of anæmia, as we saw in the last chapter; and since it generally accompanies aglobulism and deficiency of oxygen, the result is feebleness of metabolism throughout the entire body. Metabolism is also disturbed by sudden and extreme alterations of *external natural influences*, such as the temperature, moisture, pressure and electrical condition of the air; and local changes of temperature give rise to chills, colds, and rheumatism. The opinion, however, is daily growing that fever and many other disorders of metabolism are often due to the entrance into the tissues of *unnatural*, *extraneous*, or *infective* substances, whether inorganic, organic, or organised, such as foul air, the contagia of measles, scarlatina, and other exanthemata, and the organisms of malaria, syphilis, and tuberculosis. It is suggested that these organisms interfere with metabolism by settling in the tissues and carrying on an indepent metabolism of their own, that is, by living, thriving, and reproducing their like at the expense of the pabulum of the tissues; that they throw the products of their changes into the venous current, which is thus poisoned and infects the rest of the body; and that by their life-changes they cause a development of heat which constitutes one part of fever.

The *phenomena* of disordered metabolism are necessarily of endless variety and complexity. The most striking symptoms attend that kind of excessive nutrition known as *fever*, viz., wasting, increased excretion, high temperature, and general functional derangement. To this subject we shall return in chapter xiv. *Inflammation* may be broadly defined as a similar increase of metabolism in a local form. Defective local nutrition is seen in fatty and calcareous *degenerations*. In some forms of derangement the results are chiefly appreciable in connection with the tissues themselves, as in obesity; in others they are discovered in the excretions, *e.g.* gravel, and glycosuria; in many instances, such as gout, they can be found both in the tissues and excretions. Occasionally they take the form of excessive and unnatural *growth*, invading and destroying the normal structures, as in cancer. In other diseases the growth is rapidly followed by decay, as we see in syphilis and tubercle. When the derangement remains persistently, and establishes itself in the organs, without definite anatomical change, it constitutes in part the so-called *diatheses*—gouty, rheumatic, calculoid, etc. Manifestly in this great collection of diseased conditions we have an urgent demand for treatment.

IV. NATURAL RECOVERY.

Experience has taught us that many of the most common derangements of metabolism, such as fever, gravel, and rheumatism, are of but temporary duration, that is, disappear spontaneously, when the normal conditions have returned or are restored. The forms which natural recovery takes in metabolic disorder are known as *reaction and repair*, *i.e.* increased nutritive activity, often associated with *inflammation*. Unfortunately this class of derangements are peculiarly liable to recur, but this is chiefly because of the return of unhealthy circumstances. Here, too, as elsewhere, recovery is limited by anatomical changes; but even growth and degeneration will sometimes disappear, under favourable conditions.

V. THERAPEUTICS.

The rational treatment of disorders of nutrition is a subject of such large proportions that it can be discussed only in an illustrative way in the present work. A careful consideration, however, of the principles laid down under the preceding heads will, it is hoped, enable the student to extend his knowledge practically on his account.

The general treatment of disorders of metabolism involves the regulation of the whole manner of living: of the food and air, the work done, the excretions, and, above all, the careful balance of these. Muscular and nervous exercise must be ordered in fair proportion, to prevent obesity and gout on the one hand, or exhaustion and degeneration on the other.

When an actual instance of metabolic disorder demands treatment, we must first attempt to *discover its cause, and to remove it* by the same measures which might have prevented it. Thus the cause of gout may be swept from the system in many instances by a timely and thorough reform of the diet, and stimulation of the bowels, liver, and kidneys by a combined cathartic and cholagogue, followed by a saline, as recommended under the head of the Liver. Lead poisoning may be cured in the same way, by hastening the excretion of the metal by Iodide of Potassium. When these or other disorders of metabolism, such as rheumatism, syphilis, and tuberculosis, have become chronic, great benefit is derived from change of air and treatment by natural baths. We can sometimes remove fatty degeneration, that marked instance of imperfect metabolism, by removing its cause—an imperfect blood-supply, local or general, *e.g.* by Iron. In other cases we may attempt to destroy, if we cannot remove, the cause; thus it is possible (but not certain) that Mercury partly cures syphilis by directly destroying its virus; Quinine malaria; and Salicin rheumatism.

As a rule, however, in the more pronounced, the so-called specific, forms of disordered nutrition, such as tuberculosis, cancer, and syphilis, all that we can do is to *counteract the cause, and relieve or remove its effects;* that is, to treat symptoms. The specific fevers, such as typhoid and scarlatina, must be similarly treated symptomatically, for their course cannot be arrested. The pyrexia is combated by febrifuges or antipyretics, which we shall discuss fully in another chapter; the waste is repaired by nourishment; and other symptoms are relieved as they arise. Inflammation and its effects—abscess, effusions into cavities, growths, adhesions, and so on—will be treated by local stimulants or alteratives, such as poultices; friction with alcoholic, aromatic, and oily preparations; douching, baths, blisters, etc., to which we shall return in chapter xiv.; or they may demand surgical interference. In other kinds of metabolic disorders, such as tuberculosis (phthisis, consumption), we have to direct a considerable part of our treatment to the maintenance of the general nutrition, by preserving digestion, and giving highly-nutritious foods, such as Cod-liver Oil until the process has temporarily spent itself, and ended possibly with the evacuation of the diseased parts.

The question of the treatment of syphilis, chronic gout, rheumatism, and a number of local diseases probably related to these, for example, of the skin, joints, and nervous system, introduces us to the *use of alteratives.* We saw that alterative drugs act by *exercising* the tissues, and we have now to point out how exercise benefits an organ actually the seat of disease. For instance, syphilis is characterised locally by masses or patches of small-celled growths, with peculiar anatomical relations, proceeding probably to ulceration, that is, to death of the part. How do Mercury and Iodine remove these growths and thus cure the syphilis? In answer to this question it may be said that there are two ways in which it may be desirable to exercise tissues. First, there may be need of increased metabolic change in order to remove excessive growth. Mercury and Iodine act, partly at least, in this way upon syphilitic growths. They hasten the life-processes of the young cells so much, that the cells disappear in the form of products, or, as it is commonly expressed, "are absorbed." It is essential to the success of this plan of treatment that the alterative substances should be thoroughly under control, and, as we have seen, that abundant food and air be ingested to prevent failure of nutrition.

Secondly, there is an effect of exercise beyond an increase of work accomplished: work that is increased in *amount* can be changed in *kind;* exercise is beneficial, not only to the indolent individual, but to the vicious. So with the tissues. Exercise may bring them into a new, a normal, state of function, when they have been deranged or even diseased. In order to get the tissues to work normally, we must get them to work *somehow,* knowing that such work means chemical change, or even active nutritive renovation of the elements. The natural disposition which all tissues inherently possess to return to the normal, is thus afforded an opportunity of coming into play; and the result is, not a mere increase of activity, but also an *alteration in kind* of the activity. Henceforth the protoplasm, if supplied with an abundance of food and oxygen, itself returns to the normal state. This powerful effect of alterative drugs is seen in such diseases as chronic gout, skin diseases, rheumatism, and disorders of the nervous system. Besides Iodide of Potassium, the alteratives used for this second purpose are chiefly Arsenic, Silver, Antimony, Phosphorus, and occasionally Copper and

Zinc. Sulphur is a mild alterative, valuable in rheumatism and skin diseases, especially in the form of natural waters. Many vegetable substances are credited with like properties, notably Sarsaparilla, Guaiacum, Hemidesmus, Serpentary, and Mezereum, but the physiological action of these is very obscure, and their value as medicines doubtful.

SYNOPSIS OF DRUGS WHICH INFLUENCE METABOLISM

SUBSTANCES WHICH INCREASE METABOLISM. ALTERATIVES.	SUBSTANCES WHICH DIMINISH METABOLISM	LOCAL STIMULANTS. LOCAL ALTERATIVES.
Hydrargyrum	Oleum Morrhuæ.	Cadmium
Ferrum	Oleum Olivæ	Iodum
Antimonium	Glycerinum	Sulphur
Phosphorus	Alcohol	Water
Arsenicum	Quinia	Fixed Oils
Sulphur	Salicin and Salicylates	Alcohol
Calcii Sulphidum	Resorcin	Æther
Calcii Chloridum	Chinolin	Chloroformum
Calcis Hypophosphis	Kairin	Ammonia
Sodæ Hypophosphis		Volatile Oils
Water		Oleo-Resins
Guaiacum		Resins
Hemidesmus		Balsams
Mezereum		
Sarsa		
Caffein		
Guarana		
Coca		

CHAPTER X.

THE CIRCULATORY SYSTEM.

I. PHYSIOLOGICAL RELATIONS.

THE function of the heart is to drive a certain amount of blood through the whole length of the circulatory system within a given time. In its flow through the small arteries and capillaries, the blood meets with great peripheral resistance, and is dammed back, as it were, upon the larger arteries, which by virtue of the elasticity of their coats are constantly distended, and exert an equal and opposite pressure on the blood. The intermittent action of the heart is thus converted into a continuous force, *the arterial blood-pressure*, which (thanks to the aortic valves) urges the blood forwards in a steady stream.

The surface of the blood-stream is broken only in the arteries by the wave raised by each fresh discharge from the heart, and this wave is called *the pulse.*

The *heart* performs its work by virtue of being a nervo-muscular organ, freely supplied with blood by the coronaries. The muscular tissue is normally stimulated to contract by the intra-cardiac ganglia, which, whilst automatic in action, are excited by impressions coming from the inner surface of the heart—chiefly impressions of pressure or resistance; and the vigour of systole is in direct proportion to this pressure, which in turn is referable, partly to the auricular charge, and partly to the resistance ahead. The movements of the heart are regulated by the cardiac centre in the medulla, which is that part of the nervous system where afferent impressions are first received, and then reflected as motor impulses to the heart, either by the vagus or by the sympathetic, the *terminations* of which are connected with the cardiac ganglia. An impression made upon the terminations of the vagus diminishes the frequency of the nervous discharges from the ganglia, that is, *inhibits* the contractions of the heart; an impression made on the terminations of the sympathetic accelerates them. With regard to the heart- or pulse-rate, it is highly important to observe that the *length of systole varies very little:* whatever the work done or to be done, the ventricle takes $\frac{4}{10}$″ to contract. The part of the cardiac revolution that varies in length is the diastole, which is sometimes long, giving an infrequent pulse-rate, say 50, sometimes short, giving a frequent pulse-rate, say 100. Now, during diastole the nervo-muscular apparatus rests and is nourished, and the ventricles are filled from the auricles and veins. An infrequent pulse is thus (to a certain extent) an indication that the heart is being rested and filling well, whilst the force of the systole is not weakened, probably the reverse, by these two effects. Agencies which thus affect the rate of the heart through the terminations of the vagus and sympathetic, either reach them through the coronary blood, such as drugs, or are transmitted from the central nervous system through the nerve-trunks. Central impulses affecting the *force* of the heart probably reach it through the same channels.

The *cardiac centre* in the medulla is the centre of an area of impressionable matter, which is as extensive as the nervous system itself. Into this centre there pour constant streams of impressions from the vessels, abdominal viscera, skin, muscles, central nervous system (including the seat of mind), from the lungs, and indeed from every organ, including the heart itself; and thence the resulting impulses descend through the vagus and sympathetic to the heart, which is thus subject to every influence, however slight, to which the body may be exposed. Further, the cardiac centre is affected by its blood-supply, including both the quality and pressure of the blood within it.

Amongst the afferent impressions reaching the cardiac centre, those from the heart itself travel through the vagus. These are partly impressions of common sensibility, which pass through the medulla into the convolutions; and although normally too feeble to be perceived, may, if powerful, give rise to sensations of pain, distress, weight, and palpitation, referred to the præcordium.

The *arteries* are active, irritable muscular tubes, whose calibre can be modified by a variety of influences. A local nervous mechanism guides the vasor muscles; vaso-motor and vaso-dilator nerves pass between the local mechanism and the central nervous system; and there is a great central point in the medulla oblongata, called the *vaso-motor centre*, as well as other lower centres in the cord and brain, which collect impressions from every part of the body, and reflect them through the vaso-motor or vaso-dilator nerves, as the case may be, to the vessels. The muscular coat of the arteries, being constantly exercised to a degree, gives so-called "tone" to the vessels, which is one of the elements of that cardinal factor of the circulation, *the peripheral resistance*. The more active the vaso-motor nerves or centres, the greater the resistance and the higher the blood pressure; the more active the dilator, the lower the pressure; and the influence of each upon the heart respectively corresponds. Particular vascular areas, *e.g.* those of the skin and mesentery, may also be dilated or constricted independently of others. Manifestly local dilatation will admit more blood to the part, and so lower the general arterial pressure; local constriction will increase the local resistance, and so raise the general pressure. Amongst the impressions which influence the vaso-motor centre are mental states, visceral conditions, surface temperature and sensations of all kinds. It is also stimulated by deficiency of blood within itself, and by poverty of the blood in oxygen, and drugs act directly upon it as we shall presently see.

The afferent impressions which reach the vaso-motor centre from the heart are so important to the therapeutist that they demand special mention. When impressions originating in over-distension, distress, or failure of the heart, reach the cardiac centre through the vagus, they are transferred to the vasor centre, whence they are reflected to the vessels through the dilator nerves. The vessels are thus relaxed; the arterial pressure, which the ventricle has to overcome, falls; the heart empties itself more readily, and is relieved. This arrangement for reducing the intercardiac pressure is called the *depressor mechanism of the circulation.*

The *capillaries* effect the final distribution of blood to the tissues. Their soft protoplasmic walls, through which the plasma, the oxygen, and the corpuscles pass into the tissues, have irritability of their own, and they are subject to many other influences, viz. those of the nervous system, of the blood which they contain, of the arteries and the veins at either extremity, and of the activity of nutrition. In the capillaries we discover the other element of the *peripheral resistance.*

The *veins* convey the blood back to the heart as comparatively passive tubes. They are probably subject to special nervous influences, but they are chiefly influenced physically by the volume of blood passing through them, that is, by the condition of the heart in front and of the arteries and capillaries behind. Thus, shortness of diastole, *i.e.* frequency of the heart, diminishes the time of emptying the veins, and raises the pressure within them. A low arterial pressure and a free flow through the capillaries have the same effect. Conversely, the veins react physically on the heart and capillaries; if they are dilated and full, the return of the blood to the auricle is delayed, and the force of systole weakened from lowness of the charge, whilst the capillaries are obstructed, and the flow of the plasma and metabolic products between the vessels and the tissues disturbed.

We can now understand the meaning of the expression, *the general blood-pressure.* The elasticity of the arteries being taken as constant, the pressure of blood within the arterial system at any given moment will depend upon (1) the total quantity of blood in circulation; (2) the action of the heart; (3) the freedom of the flow into the veins, *i.e.* the peripheral resistance, due to vasor constriction and capillary obstruction. The arterial pressure is so far self-regulated, through the quantity of blood in circulation, by means of the Malpighian bodies of the kidney. In this mechanism, the general arterial pressure is brought to bear upon a length of unsupported arteriole, so as to press or excrete the water of the blood through the vascular wall into the uriniferous tubule. By the muscular and nervous structures in the walls of the afferent and efferent arterioles, the pressure upon the glomerulus may be cut off, or thrown on, as the system requires, the result being less or more watery excretion, and corresponding rise or fall of the blood pressure. The perspiratory excretion, and, indeed, all exudations, probably act in the same way as the urinary, only less powerfully.

Another powerful influence on the circulation as a whole is muscular activity, exertion being attended by cardiac excitement and high arterial pressure, and muscular rest by calm action of the heart and a quiet pulse.

II. PHARMACODYNAMICS.

The circulatory system affords one of the most striking instances in the body of provisions for physiological change, and of functional reaction to influences of every kind which bear, or may be brought to bear, upon it. Herein lie at once its power of accommodation to circumstances and its vulnerability; and here, too, the therapeutist discovers his opportunity of influencing the heart and vessels at his pleasure.

1. The *total volume of blood in circulation* being one of the prime factors of the blood pressure, every change in this volume, whether by abstraction or addition, must alter the pressure. This can readily be accomplished by leeching, cupping or *venesection* on the one hand, or by *transfusion* on the other hand. As a matter of fact, however, the effect of either method on the circulation is but temporary. The tension of the pulse falls with venesection, only to rise again quickly by increased absorption of fluids from the tissue and bowels into the circulation. Transfusion raises the blood pressure for a time, but the compensating mechanisms soon restore the previous average pressure. Venesection is therefore the most powerful of all measures for quickly taking the tension off the whole circulation, and relieving the heart and lungs, but it is practically useless for the purpose of permanently reducing the blood pressure; and transfusion is similarly of inestimable value in rapidly restoring the pressure, if it have fallen dangerously low from loss of blood, and thus preventing death by circulatory failure.

2. *The Heart.*—*a. The intrinsic nervo-muscular apparatus* may be either *stimulated* or *depressed.* The first direct cardiac *stimulant* is an active coronary circulation, through which the heart responds to improved quality of the blood in oxygen and plasma, and thus, indirectly, to proper air and food, healthy digestion, and hepatic action. Direct cardiac stimulants include many drugs, such as Alcohol, Digitalis, Scilla, Strychnia, Ammonia, Ether, etc. The continuous battery current applied through the region of the heart acts similarly. *Reflex* stimulation is a ready and powerful means of increasing the activity of the heart, or of rousing it in actual arrest, and includes the various methods of local nervous stimulation described in chapter xi., especially irritation of the fifth nerve by Ammonia, the cold douche and flagellation, and counter-irritation of the præcordium. Cupping and leeching also exert a stimulant influence on the heart through the nervous system, as well as relieving it by abstraction of blood. Carminatives stimulate

the heart, partly directly, partly by reflexion through the central nervous system of their impression on the gastric mucosa. *The mind* is a powerful instrument for invigorating the heart. Cheerfulness and encouragement may be more useful to a patient than many drugs. Lastly, all measures which lengthen the diastole (slow the heart) increase the cardiac strength by affording more time for rest.

The intrinsic nervo-muscular apparatus may be *depressed* or *soothed* by the opposite set of measures; by a low coronary pressure, the effect of low diet, purgatives, diuretics, and diaphoretics; by arresting reflex impulses by means of general, peripheral, and central nervous sedatives, such as Opium, warmth, or plasters applied to the præcordium, and the general warm bath; and by all measures which shorten the diastole, *i.e.*, increase the rate of the pulse. Lastly, we have a number of drugs which are direct cardiac depressants, including Opium, Diluted Hydrocyanic Acid, Aconite, Antimony, Potash, Chloroform, Chloral, Ergot, Veratria, Ipecacuanha and many more.

The *afferent nerves of the heart*, which carry to the brain the impressions of common sensibility originating in the cardiac tissues, may be depressed by means of Opium, Chloral, Belladonna and its allies, and possibly by heat and cold.

b. The terminations of the vagus in the heart may be *stimulated*, and the cardiac action rendered less frequent, by Digitalis and Scilla. The same part of the inhibitory mechanism may be *depressed*, and the rate of the heat increased, by Belladonna, Hyoscyamus, Stramonium, Amyl Nitrite, and large doses of many drugs. These local measures act very powerfully.

c. The *cardiac centre* in the medulla is readily *stimulated* by certain drugs, such as Digitalis and Scilla, Ether, Alcohol and Chloroform at first, Strychnia, and Belladonna; and by many peripheral nervous impressions, such as counter-irritation and cold. On the other hand it can be *depressed* by warm applications to the surface, such as the hot bath, and by certain drugs, including Chloroform and Alcohol after the first stage, Aconite, Antimony, Opium, Chloral, Diluted Hydrocyanic Acid, Ipecacuanha, Nitrite of Amyl, Physostigma, and Conium. Our control of the inhibitory action of the vagus at either extremity, that is, of the frequency of the heart, is of much value from the power which it affords us of influencing the cardiac nutrition and strength, by lengthening or shortening the diastole or resting-time of the ventricle. Thus it will be found that all cardiac retarders are cardiac stimulants, whilst all cardiac accelerators prove in the end to be cardiac depressants.

In this connection muscular *exercise* and *rest* must be mentioned as the most powerful and available of all the measures which increase and diminish, respectively, the work and nutritive activity of the heart. Rest in bed, avoidance of walking, carriage exercise, movement on level ground, are a descending series of means of giving the heart rest, and the different kinds of wholesome muscular exercise are equally valuable means of throwing work upon the heart, when its condition demands increased activity.

3. *The Arteries.*—The peripheral resistance in the arteries introduces us to a vast number of pharmacodynamical influences which we must be content simply to enumerate:

a. The vaso-motor centre can be *stimulated* directly by Alcohol and Chloroform (temporarily), by Ether, Ammonia, Strychnia, Digitalis, and Scilla; by irritation of the sensory nerves in any accessible part of the body—for instance, by cold, counter-irritants such as mustard, etc., applied to the calves or soles, by stimulation of the trigeminus, the most ready and powerful means of which is Ammonia held to the nose. On the other hand, the vaso-motor centre may be directly *depressed*, by Alcohol and Chloroform in the second stage, by Opium, Chloral, Diluted Hydrocyanic Acid, Antimony, Ipecacuanha, Aconite, Belladonna and its allies; by muscular rest; by emotional quiet and balance; and by local sedatives, such as anodynes, warmth, and gentle friction.

b. The local vaso-constrictor mechanism in the arterial walls is stimulated directly by Lead and Silver, Digitalis and Squill, in the first stage, Ergot; and by local cold, produced by irrigation with water, by Ether spray, or by evaporation of spirituous, acid, and saline solutions, such as lotions of Rectified Spirit, Vinegar, and Chloride of Ammonium. We call these measures **vascular astringents.**

Vascular *dilatation* may be effected through the same local mechanism by the Nitrites of Amyl and Sodium, Nitroglycerine, Alcohol, and Belladonna; by the local heat afforded by poultices and fomentations; by the whole group of Volatile Oils, of which Turpentine and Camphor are the types; by Acrid Oils, including Mustard and Mezereon; by irritant metals and metalloids, such as Zinc, Copper, and Iodine; and artificial carbon compounds, including Creasote, Carbolic Acid and their allies. Local vascular dilators are naturally **local circulatory stimulants.** The continuous current also causes local vascular dilatation.

4. *The Capillaries.*—As one of the causes of peripheral resistance, the condition of the capillary areas is an object of great interest to the therapeutist. We can *dilate* the capillaries and increase the flow through them by either local warmth or persistent cold, by friction, and by local nervous irritants, such as the confined vapour of Spirits, Mustard, Aromatic Oils, and other rubefacients. This is but an early stage of the process of in-

flammation, characterised by capillary dilatation and escape of the constituents of the blood, which can be induced by a continuation of the same measures, or by excessive heat, Cantharides, Croton Oil, etc. (vesicants and pustulants), and markedly modifies, as we shall see in chapter xiv., the capillary circulation of neighbouring parts, and the general blood pressure.

On the other hand, we can *contract* the capillaries and diminish the flow through them by the application of excessive local cold (congelation and refrigeration), by Lead, and Silver, which are pure astringents; and by the **constringents**, namely, Tannic and Gallic Acids, and the many vegetables which contain them (Kino, Catechu, etc.), which constringe or "tan" the connective tissues supporting the delicate capillaries, by condensing their gelatinous and albuminous constituents. Some substances, such as Persalts of Iron, may also arrest the circulation in the capillaries, by promoting coagulation of the blood within them.

5. Our influence upon the walls of the *veins* appears to be but small. The veins of a part may be dilated by hot applications; contracted, and then dilated, by moderate local cold. Ergot is believed by some authorities to relax the venous walls. Indirect measures are more powerful in our hands. The heart *a fronte*, or the arterial pressure *a tergo*, may be employed, as we have seen, to increase or diminish the venous pressure. The processes of secretion and excretion are not less powerful in modifying the fulness of the veins. Thus, hydragogue purgatives, as we have seen, drain the portal system; and we shall afterwards find that saline diuretics relieve the renal veins in a very similar way.

III. Pathological Relations.

The complex circulatory apparatus is subject to many forms of derangement and disease, a few only of which require to be noticed for the purpose of illustrating the application of drugs and other therapeutical measures.

1. *Disorders* of the heart and vessels belong chiefly to three classes, according to their causes: (*a*) They may be due to direct *nervous* causes, such as mental excitement or depression, or to some cause acting reflexly through the nervous centres in the medulla, such as derangement of the stomach, intestines, uterus, etc. (*b*) They may originate in morbid states of the *blood*, especially anæmia, which disturbs the centres in the medulla, the vessels, and the nervo-muscular structures in the heart. Or (*c*) they may be traced to a *poison* in the system, *e.g.* tobacco, tea, alcohol, lead, and the poison of gout, each of which has a specific action on some part of the mechanism.

2. *Organic disease* will be sufficiently illustrated by a well-marked case of progressive heart disease from some morbid state of the aortic valves. These valves, from their position and constant movement, are peculiarly subject to disease. They thus become distorted or even destroyed, and rendered unfit to direct the movements of the blood, which is consequently obstructed in its exit from the heart in systole, and regurgitates from the aorta during diastole. The great power of adaptation to change of circumstances possessed by the circulation is generally sufficient to *compensate* for moderate valvular disease, by hypertrophy of the muscular walls of the heart. The serious symptoms set in *when compensation fails*, *i.e.* as a rule, when the nutrition of the ventricular wall is insufficient to supply the increased—possibly ever-increasing—demand for muscular force. The order of events is then as follows: systole fails to overcome the intraventricular pressure; the chamber is imperfectly emptied, and therefore over-distended in diastole; the walls are stretched; and the cavity is *dilated*. Pain and "oppression" make their appearance at this stage, and cause great distress. Henceforth derangement proceeds apace. With the dilatation of the chamber, the mitral valve becomes incompetent or misfitting; blood regurgitates in systole into the left auricle; the pulmonary circulation becomes over-distended; the obstruction makes itself felt in the right ventricle; and, after a time, in the right auricle, by forcing the tricuspid. The systemic veins now become congested from obstruction *a fronte;* the viscera become loaded with venous blood; their functions are disordered; and hæmorrhage, dropsy, fluxes of plasma from the bowels and bronchi, and discharges of albumen in the urine occur. These derangements, coupled with those of respiration, the cardiac distress, and the effects of anæmia from imperfect arterial supply, finally render life impossible. During this process of backward dilatation, the cardiac action is necessarily disordered in all respects, the strength and regularity of the pulse giving way, and its rate being decidedly accelerated.

3. *Hæmorrhage.*—Bleeding produces certain effects on the system, partly referable to loss of blood, and partly to fall of the blood pressure. It is naturally arrested by this fall of pressure, by coagulation of the blood at the seat of disease, and by retraction of part of the coats of the vessel. If the hæmorrhage be severe, fainting or *syncope* occurs, that is, loss of consciousness from failure of the heart and consequent deficiency of blood and blood pressure in the brain. Any other cause of cardiac failure will produce the same effect. At the same time, the weight of the body cannot be supported on account of

the general muscular paralysis, which is another result of the cerebral anæmia; and the patient falls. The recumbency fortunately has a favourable effect: it restores the circulation through the cardiac and vaso-motor centres, increasing their activity; and renders the cerebral centres more responsive to afferent impressions.

IV. NATURAL RECOVERY.

The whole circulatory system is furnished with so many and so accurate regulating and compensating mechanisms, that not only the great range of normal conditions to which it is exposed, but even many morbid changes, can be successfully met. The chief of these provisions for preventing or counteracting disease are the reserve force of the heart; the power of compensatory hypertrophy; the depressor mechanism; the arrangements for relief of the vessels by escape of the fluid portions of the blood through the kidneys and bowels, and into serous spaces; and the natural mode of recovery from hæmorrhage and syncope. All these methods of natural relief or recovery are full of suggestions to the therapeutist, and rational treatment must follow nature's lines. The two circumstances which chiefly set a limit to compensation are failure of the coronary arteries to supply the hypertrophied walls, and suddenness of the cardiac lesion, which may hopelessly disturb the circulation before there is time for hypertrophy to occur.

V. THERAPEUTICS.

Although the details contained in the four preceding sections are very numerous and complex, the rational therapeutics of the diseases of the heart and vessels can be sufficiently illustrated by a few simple principles. The grand fact that stands out prominently amongst all the others is that dilatation must be prevented or relieved. It is a purely physical effect or state, resulting from the failure of the great physiological condition on which alone the circulation can be and is carried on, namely, that the driving power must always be greater than the resistance, *i.e.* whilst it varies with it, it must never fall below it. There are many other indications for treatment, but none that approach this in importance.

The general treatment of disorder and disease of the heart will mainly consist in ensuring an equable manner of life. Extraordinary influences of every kind, bodily and mental, especially exertion and excitement, must be shunned by persons suffering from cardiac disease, or in whom any of its common causes may be at work. When disease attacks the valves (endocarditis), *e.g.* in acute rheumatism, absolute bodily rest is essential to relieve the strain from them and the frequency of their movements; and cardiac depressants, such as Potash, Aconite, and Veratria, are employed to assist this effect.

Removal of the cause is rarely practicable in heart disease. The opposite is the case in cardiac disorder. Treatment here consists in relieving dyspepsia, in restoring the condition of the blood, in securing mental rest, and in removing all poisons from the system, such as alcohol, tea, and tobacco, by a reformation of diet and personal habits. Carminatives are specially valuable in dyspepsia with palpitation.

A great part of the treatment of diseases of the heart consists in *counteracting the cause*; that is, in *the prevention and removal of dilatation.* The first rational step to be taken is to lighten the load upon the heart, to lower the intraventricular pressure which it is unable to overcome. Rest, bodily and mental, is the most obvious and easy means of doing so, the patient being kept in bed, and every kind of exertion and excitement forbidden. The pressure may be further reduced by purgation, which diverts and drains the blood; or, if the condition be urgent, blood must be removed by leeching, cupping, or venesection, all of which may give great relief, or even preserve life when it is threatened. In another class of cases, the arterial tension may be lowered by means of drugs. Nitrite of Amyl acts very swiftly in this way, giving relief in that terrible form of acute distension of the heart which is called "angina pectoris," by instantly relaxing the vessels in front, as well as by accelerating the cardiac action. The same effect may be more slowly produced by the alkaline Nitrites, Potash salts, and Belladonna.

The second means of treating dilatation is by *increasing the cardiac power by direct cardiac stimulants*, such as Digitalis, Scilla, Alcohol, and Ammonia. Mustard or other rubefacients applied to the præcordium are *indirect* cardiac stimulants of great value in these cases. At the same time, the quantity and quality of the blood supplied through the coronaries to the cardiac walls must be sustained by nutritious food, and possibly by Iron: a system which demands, in turn, the strictest attention to the action of the stomach, bowels, and liver, flatulence and other digestive disturbances being highly dangerous to a weak heart.

The third means of treating dilatation is by *increasing the time of cardiac rest.* Three powerful direct cardiac stimulants, Digitalis, Scilla, and Convallaria, have the additional action of stimulating the inhibitory apparatus, both in the heart and medulla. They increase the force of the systole, thus thoroughly emptying the chamber, and preventing over-distension; they lengthen the time of filling the heart, that is, of emptying the veins, thus favouring the venous flow; they afford rest to the heart; and they also increase the arterial pressure, not only by filling the aorta better, but by stimulating the vaso-motor nerves. They are therefore indicated in that backward dilatation of chamber after chamber, ending in dropsy and visceral congestion, which we have discussed, and as a matter of fact they prove of the very greatest value in practice.

Removal of effects: Treatment of symptoms.—Cardiac pain, oppression, anxiety, and other forms of distress, can be relieved by cardiac sedatives, such as local heat or cold, Opium, Chloral and Belladonna. Of these, Opium is the most powerful, and of the greatest value. We must never forget, however, that in Opium we are administering a dangerous cardiac depressant, which paralyses in large doses every part of the circulatory apparatus; and the same remark applies to Chloral. The perfection of the therapeutic art is to use these remedies with judgment. The hypodermic injection of Morphia sometimes gives complete relief. Belladonna is a cardiac anodyne much more easily employed, because less depressant; but is much less efficacious. It is frequently applied locally to the præcordium as the Emplastrum. A rubefacient or even slight vesicant effect on the surface of the chest quickly relieves cardiac pain. Pulmonary distress from congestion of the bronchi and alveoli may be specially relieved by stimulant expectorants, such as Ammonia and Scilla, which increase and remove the bronchial flux; but here again the value of rational treatment is seen in the disappearance of dyspnœa, hæmoptysis, cough, and the physical signs of pulmonary engorgement, under the influence of purely cardiac remedies, such as Digitalis and Alcohol. Dropsy may be immediately relieved by puncture of the part, but like other symptoms disappears rapidly by the veins when the cardiac strength is restored. The same remarks apply ot the visceral congestions and their temporary relief by purgatives. Diuretics are of great service in cardiac dropsy, acting partly by relieving the renal veins (salines), but chiefly by raising the arterial pressure (Digitalis and Scilla), as is fully discussed under the head of The Kidney in chapter xii.

Hæmorrhage — Hæmostatics. — External hæmorrhage is readily arrested by surgical means. If the lesion be internal, as in the stomach or lungs, we must trust chiefly to medicinal remedies which are known as **hæmostatics.**

(*a*) So far the *cardiac depression* caused by the hæmorrhage may be cautiously encouraged. In every case it is desirable to employ all available means of reducing the force, not the power of the heart, especially bodily and mental rest; and for this purpose general sedatives—Opium especially—are valuable adjuvants to the more direct measures.

(*b*) It is also desirable to take the pressure of the circulation off the bleeding point by *dilatation of a vascular area* in the neighbourhood, and in anastomotic connection; or by inducing a watery flux from it. Thus we employ purgatives in hæmorrhage from the stomach, due to portal congestion, in hæmoptysis or bleeding from the respiratory passages, and in cerebral hæmorrhage, so as to dilate the mesenteric vessels and produce a hydragogue action on the bowels.

(*c*) The *local* measures employed for hæmorrhage are variously known as **local hæmostatics, styptics**, or local vascular astringents. They are imitations or adjuvants of the natural means just analysed, and belong to three distinct classes, according as they act upon, (1) the *blood*, (2) *the vessel walls*, or (3), the *perivascular tissues*.

(1) Hæmostatics may act upon the *blood*, hastening coagulation or precipitating albumen, and thus stopping the bleeding point. Such are Tannin, and the many vegetable substances containing it—Kino, Rhatany, Catechu, Logwood, Galls, Oak-bark, etc.; Alum, Persalts of Iron, Sulphate of Copper, Sulphate of Zinc, Acetate of Lead, Nitrate of Silver, and Diluted Mineral Acids. Matico probably acts physically.

(2) The hæmostatics which promote *contraction of the broken vessel* are Nitrate of Silver and Acetate of Lead—both very powerful; Ergot; and local cold.

(3) Substances acting upon *the perivascular tissues* may be made to arrest hemorrhage by combining with the connective tissues, coagulating or precipitating their albuminous substances, and rendering them more compact than normal, or constringed so that the bleeding vessels are compressed and closed. Such are—Tannin and its allies just enumerated, Lead, Silver, Persalts of Iron, and Alum.

Syncope.—Syncope demands prompt treatment. Nature suggests the first step: the patient must be laid down, with the head at least as low as the heart, so as to restore the pressure and the blood in the cardiac centre. Every possible means must then be used to restore the suspended action of the heart, including direct and indirect cardiac stimulants. The most available of these internally are Ammonia and Alcohol in the form of spirits, or wine; externally, the application of cold, fresh air, flagellation or flicking with wet towels, ammonia held to the nostrils, and the continuous current to the præcordium. Nitrite of Amyl acts quickly in some cases. If swallowing be impossible, Brandy or Ether must be injected into the rectum, or under the skin.

SUBSTANCES WHICH ACT UPON THE CIRCULATORY SYSTEM.

SUBSTANCES STIMULATING CARDIAC CENTRE.

- Digitalis
- Scilla
- Convallaria
- Belladonna (at first)
- Stramonium (at first)
- Hyoscyamus (at first)
- Tabacum (at first)
- Alcohol (at first)
- Æther (at first)
- Chloroformum (briefly)
- Veratria (at first)
- Physostigma (briefly)
- Opium (briefly)
- Ammonia
- Strychnia

SUBSTANCES DEPRESSING CARDIAC CENTRE.

- Digitalis (at last)
- Scilla (at last)
- Belladonna (at last)
- Stramonium (at last)
- Hyoscyamus (at last)
- Tabacum (at last)
- Alcohol (at last)
- Æther (at last)
- Chloroformum (at last)
- Chloral Hydras
- Acidum Hydrocyan
- Veratria (at last)
- Aconitum
- Physostigma (chiefly)
- Opium (chiefly)
- Antimonium
- Ipecacuanha
- Conium
- Amyl Nitris
- Nitrites

SUBSTANCES STIMULATING NERVO-MUSCULAR APPARATUS.

- Digitalis (at first)
- Scilla (at first)
- Camphor (at first)
- Strychnia
- Alcohol
- Ether
- Convallaria
- Veratria (at first)
- Senega (at first)
- Opium (briefly)
- Ammonia

SUBSTANCES DEPRESSING NERVO-MUSCULAR APPARATUS.

- Antimonium
- Bromum
- Digitalis (at last)
- Scilla (at last)
- Camphora (at last)
- Belladonna (at last)
- Hyoscyamus (at last)
- Stramonium (at last)
- Lobelia
- Arnica (at last)
- Tabacum
- Alcohol (at last)
- Æther (at last)
- Chloroformum
- Chloral Hydras
- Acidum Hydrocyanicum Dil.
- Aconitum
- Ol. Terebinthinæ (specifically)
- Ergota
- Veratria (at last)
- Colchicum
- Senega (at last)
- Physostigma (at last)
- Opium (chiefly)
- Ipecacuanha
- Potassium
- Lithium
- Purgatives
- Diuretics
- Diaphoretics

SUBSTANCES STIMULATING INHIBITORY APPARATUS.

- Digitalis (at first)
- Scilla (at first)
- Convallaria
- Senega (at first)
- Belladonna (briefly)
- Stramonium ,,
- Hyoscyamus ,,
- Tabacum (at first)
- ? Ergota
- Opium (briefly)
- Plumbum (indirectly)

SUBSTANCES DEPRESSING INHIBITORY APPARATUS.

- Amyl Nitris
- Nitrite of Sodium
- Nitro-glycerine
- Spiritus Œtheris Nitrosi
- Digitalis (at last)
- Scilla (at last)
- Senega (at last)
- Belladonna (in ordinary doses)
- Stramonium (in ordinary doses)
- Hyoscyamus (in ordinary doses)
- Tabacum (at last)
- Chloral Hydrate
- Opium (chiefly)

SUBSTANCES WHICH ACT UPON THE CIRCULATORY SYSTEM (*continued*).

GENERAL VASO-MOTOR STIMULANTS.

Digitalis (at first)
Scilla (at first)
Belladonna (briefly)
Stramonium (briefly)
Hyoscyamus (briefly)
Strychnia
Alcohol (at first)
Æther (at first)
Chloroformum (at first)
Acidum Hydrocyanic. (at first)
Veratria (at first)
Ammonia
Plumbum

GENERAL VASO-MOTOR DEPRESSANTS.

Amyl Nitris
Nitrite of Sodium
Nitro-glycerine
Spiritus Ætheris Nitrosi
Digitalis (at last)
Scilla (at last)
Belladonna (in ordinary doses)
Stramonium (in ordinary doses)
Hyoscyamus (in ordinary doses)
Lobelia
Tabacum
Alcohol (at last)
Æther (at last)
Chloroformum
Chloral (central and periph.)
AcidumHydrocy. (at last)
Veratria (at last)
Opium (moderately)
Antimonium
Ipecacuanha
Aconitum

LOCAL CIRCULATORY DEPRESSANTS: VASCULAR ASTRINGENTS.

Alcohol (evaporating)
Æther ,,
Chloroformum ,,
Plumbum
Argentum
Digitalis
Hamamelis
Constringents

LOCAL CIRCULATORY STIMULANTS.

Iodum
Camphora
Arnica
Alcohol (confined)
Æther (confined)
Chloral Hydras
Ol. Terebinth.
Veratria
Sinapis
Cantharis
Ammonia
Metallic Salts
All Aromatic Volatile Oils, Oleo-resins, Resins, and Balsams.
Acid. Carbolic.
Creasotum.

STYPTICS.

Matica
Tannicum Acidum
Galla
Quercus
Krameria
Catechu
Hematoxylum.
Alumen
Ferrum

REFLEX CARDIAC STIMULANTS.

Alcohol
Æther
Chloroformum
Sinapis
Ol. Terebinthinæ (reflex)
Ammonia
Carminatives
Counter-irritants
Bitters

REFLEX VASCULAR STIMULANTS.

Alcohol
Æther
Chloroformum
Sinapis
Ol. Terebinthinæ (reflex)
Ammonia
Carminatives
Bitters
Counter-irritants

SUBSTANCES LOWERING BLOOD PRESSURE IN UNCERTAIN MANNER.

Ergota
Physostigma (chiefly)
Barium

CHAPTER XI.

THE RESPIRATORY SYSTEM.

I. PHYSIOLOGICAL RELATIONS.

THE *red corpuscle* of the blood is the oxygenating or respiratory element of the body. The physical part of respiration is carried on by means of the chest and respiratory passages, a fresh supply of oxygen being continually presented to the red corpuscles, and carbonic acid, water, and heat given off from the plasma.

The red corpuscle and the chest are brought into functional relation with each other by means of a special nervous mechanism, called the *respiratory centre*, a portion of nervous matter in the medulla oblongata which is peculiarly irritable in the presence of oxygen, and sends motor impulses through the cord to the respiratory muscles.

The less the amount of oxygen admitted to the respiratory centre, the more powerfully is it stimulated, and the chest moved; the greater the amount of oxygen admitted to the centre, the less powerful its discharges, and the more weak or superficial is the breathing. Now the amount of oxygen in the arteries of the medulla is the same as in the systemic arteries generally; and we thus find that the state of oxygenation of the arterial blood governs the respiratory movements through the medium of the respiratory centre. The fundamental canon in the physiology of respiration is that *the condition of the red corpuscle is the prime mover of all respiratory acts.* Carbonic acid has no direct effect on the respiratory centre.

The term "centre" implies that certain influences meet in this point, originating in a circle of which it is the middle point; and this is the case. Falling into the respiratory centre are impressions conveyed by afferent—usually sensory—nerves, from every part of the body, modifying its activity, and reflexly influencing the respiratory movements. The vagus is peculiarly capable of stimulating the centre; thus irritation of the larynx immediately causes the reflex respiratory act called cough. The vagus is therefore said to be the special afferent nerve of respiration; the whole surface of the respiratory passages, and probably the lungs, being abundantly supplied with rootlets of the vagus, which are incessantly collecting impressions for transmission to the centre. Every change in the distension of the lungs, and in the quantity and quality of the pulmonary blood, thus instantly tells on the respiratory movements. It must also be carefully noted in this connection that diminished oxygenation of the blood, whilst increasing the respiratory activity, stimulates the other two great centres in the medulla, increasing the arterial resistance through the vaso-motor centre, and slowing the heart through the cardiac centre.

The afferent impressions from the lungs and respiratory passages, besides falling into the respiratory centre, also reach, if sufficiently powerful, the convolutions, where they are felt as various *sensations*, referred more or less accurately to the respiratory organs. In health these sensations of common sensibility are feeble; and we do not appreciate them until they are converted into sensations of pain, oppression, distress, or irritation, in disorder or disease.

Amongst the nerves of the respiratory muscles one group demands special notice, viz. those distributed to the bronchi. These are motor filaments of the vagus, which originate in the respiratory centre and supply the muscles regulating the calibre of the air-tubes. They bring the bronchi under the control of the medulla, and thus of the afferent impressions, especially of those very impressions which originate in the respiratory passages, the seat of their own distribution.

II. PHARMACODYNAMICS.

The extensive relations of the respiratory organs to the external air, to the blood and circulation, and to the nervous system, afford us abundant means of influencing their mode of action. These means we will now review in their natural physiological order:

1. *The Air.*—The air which comes in contact with the organs of respiration may be altered in five different respects, each of which will have a physiological effect upon the functions of the lungs, viz. as regards (*a*) its *absolute amount*, (*b*) its *chemical composition*, (*c*) its *temperature*, (*d*) its *moisture*, and (*e*) its *pressure*.

(*a*) The supply of air, like that of the food, may be entirely *arrested* for a time, another gas with different physiological properties, such as Nitrous Oxide, being allowed to take its place. Or the amount respired may be simply *reduced*, by administering rarefied air; or *increased*, by admitting oxygen or compressed air into the lungs. The same effects may be produced by ordering little or much muscular exercise respectively.

(*b*) The *chemical composition* of the atmosphere, physiologically speaking, relates only to the amount and quality of the oxygen. The proportion of oxygen to nitrogen in the air may be modified by arrangements for special inhalation, but practically this is seldom attempted, mountain and ocean climates affording us a much more satisfactory supply of pure air.

(*c*) The *temperature* of the air respired may be modified either by selecting particular climates—tropical, sub-tropical, temperate, or cold; by artificial regulation of the atmosphere of the room—ventilation, heating, etc.—or by arrangements for warming or cooling the ingoing current of air only, by means of so-called "respirators," and by recommending nasal breathing only, or oral breathing only, as the case may be.

(*d*) The amount of *moisture* in the air respired can be altered at pleasure, whether by residence in a dry climate or in a moist climate, or by varying the amount of watery vapour in the air of the room, or in the individual inspiratory draughts, by means of steam kettles, hot-water inhalations, etc.

(*e*) Lastly, the *pressure* of the air is completely under our command; and this again either by means of climate (elevated mountain residence), or by local artificial arrangements such as the air-bath and pneumatic apparatus. The *compressed air-bath*, at a pressure of $\frac{1}{5}$ to $\frac{1}{2}$ of an atmosphere above the normal, increases the amount of oxygen admitted into the blood, as well as the vital capacity and the size of the lungs, whilst it renders respiration less frequent and more easy. A rarefied atmosphere is never given as a bath; on elevated mountains it increases the depth and frequency of respiration and the vascularity of the lungs, so that there is a tendency to hæmorrhage from the alveoli. The *pneumatic apparatus*, a small gasometer, admits air under artificial pressure to the respiratory passages only, the patient breathing into, or out of, a valved tube connected therewith. Inspiration of air compressed by about $\frac{1}{60}$ atmosphere increases the amount of air entering the chest, and eventually the vital capacity, the size of the chest, and the respiratory force, whilst it diminishes the vascularity of the lungs and raises the arterial pressure. The other methods of *aërotherapeutics* do not require mention here.

2. *The Red Corpuscle.*—The red corpuscle as the great medium of external and internal respiration, as well as the prime mover of the respiratory centre, is an important agent through which the respiratory activity may be modified by food, drugs, and all the ordinary natural influences, studied in chapter viii.

3. *The Circulation.*—The corpuscles must be circulated by the heart and vessels, and any effect that we may produce upon these will greatly modify the respiratory functions. The pharmacodynamics of the circulation are discussed in the preceding chapter.

4. *The Lungs and Air-passages.*—(*a*) *The afferent or sensory nerves* of the respiratory organs are *stimulated* by cold and dry air, Chlorine gas, Ipecacuanha, Senega, Tobacco, Nitre fumes, Ammonia, and Antimony. They are *depressed* or soothed by warm and moist air, warm food, warm applications to the chest wall; possibly by demulcent substances to a small extent; and by Opium, Chloral, Chloroform, and Ether. *Sensations* connected with the respiratory organs may be modified by the same means, the nerve-depressants thus proving to be pulmonary anæsthetics or anodynes, as well as interfering with reflex respiratory acts.

(*b*) *The vessels of the bronchi* may have the circulation through them *increased* by all measures which increase the activity of the circulation generally, viz. by purgation, exercise of the lungs, and bodily movement; by Digitalis, Scilla, Ammonia, Alcohol, Strychnia, and probably the whole series of Aromatic Oils to be presently noticed. *Per contra*, the bronchial circulation may be *depressed* by all cardiac and general vascular depressants, including heat, Alkalies, Iodides, Aconite, Antimony, and Ipecacuanha.

(*b'*) *The pulmonary circulation* bears very complex relations to the respiratory movements, as regards the pressure and rate of flow in inspiration and expiration, ordinary and extraordinary. Manifestly as regards the general circulation, the pulmonary vessels may be modified by every influence which affects it, such as blood-letting, transfusion, purgation, a variety of drugs, and muscular rest or exercise. We possess one substance, non-officinal, which specifically contracts the pulmonary vessels, namely Muscarin, the active principle of the mushroom.

(*c*) *Glands of the bronchi.*—The secretion of bronchial mucus may be *increased* by alkalies, especially Ammonia; by Iodine, Sulphur, and Antimony; by Ipecacuanha, Senega, Tobacco, Scilla, and the great group of Aromatic Volatile oils, Oleo-resins, and Balsams, including Turpentine, Camphor, Benzoin, Copaiba, Ammoniacum, and the balsams of Peru and Tolu. Warm liquid food remarkably increases the bronchial secretion; on the contrary, cold dry food *diminishes* the bronchial mucus, as possibly do Belladonna, Stramonium, and Hyoscyamus, and certainly acids.

(*d*) *The nervo-muscular structures* of the bronchi and larynx are *stimulated* by those measures which act upon the afferent nerves (*a*) and perhaps they are also directly influenced by some of the same.

A group of substances of great therapeutical interest directly *depress* the same system, and so relax the bronchial walls and favour the movements of the respiratory air, viz. Belladonna, Stramonium, Hyoscyamus, Lobelia, and Tobacco; Opium, Chloral, and Cannabis Indica; Chloroform, Ether, Amyl-nitrite, and Iodide of Ethyl; Conium, and warm moist air.

5. Impressions reaching the respiratory centre through *other channels than the vagus* afford us a remarkably ready means of affecting it. Impressions may be *stimulating*, including irritation of the fifth cranial nerve in the nose by Ammonia, or on the brow by cold; of the olfactory nerve by odoriferous substances; of the optic and acoustic nerves by powerful light and sounds respectively; and of the nerves of the skin generally by painful impressions, such as flicking with towels, flagellation or slapping, extreme heat, mustard plasters, and other powerful local irritants. Or we may use measures with a *sedative* influence on the respiratory centre, including gentle warmth to the surface of the chest in the form of poultices and fomentations, warm baths, and local anæsthetics or anodynes, such as plasters and liniments of Opium, Belladonna, and Volatile Oils (Turpentine, Camphor, etc.) applied to the chest-walls.

6. *The Respiratory Centre.*—Besides those influencing the afferent impressions, a variety of direct stimulants and depressants of this centre are in our possession. The force of the nervous discharges may be *increased* by Ammonia, Strychnia, Belladonna, Stramonium, and Hyoscyamus; probably by Ipecacuanha and Antimony temporarily; and by Alcohol, Ether, and Chloroform, for a brief period at the commencement of their action. On the other hand, the last-named drugs quickly *diminish* the force of the respiratory centre (Ether less rapidly than the others); and the same effect may be produced by means of Chloral, Opium, Aconite, Veratria, Conium, and Physostigma.

7. *The Tracts of the efferent impulses from the respiratory centre, the Spinal Centres* of the respiratory muscles, and *the Nervo-muscular Apparatus* of the chest and larynx may be *stimulated*, not only reflexly, but directly, by Strychnia, which greatly increases the vigour of the spinal centres; by electricity applied to the nerve trunks (phrenics, intercostals), or to the muscles directly; and by all measures which improve the nutrition of the nervo-muscular tissues, such as well-ordered exercise. Conversely, these parts may be *depressed* by Physostigma, which greatly diminishes the vigour of the spinal centres; by Conium, which paralyses the motor nerves; and by Opium, which depresses the whole efferent mechanism. The use of these depressing measures is almost confined to the muscles of the larynx. Most powerful of all is the method of arresting, or at least controlling, the movements of the chest, by direct restraint, which is best accomplished by means of strapping or bandaging.

When we review the various measures classed under the 1st, 4th, 5th, 6th, and 7th preceding heads, we are enabled to re-arrange several of the most important of them into new groups with definite pharmacodynamical properties and important therapeutical bearings. These groups are—(A) *Expectorants;* (B) *Antispasmodics;* and (C) *Respiratory Sedatives.*

A. **Expectorants.**—Expectoration, the discharge of the sputa, or secretions and other products of the respiratory passages, will manifestly vary with the *amount* and *characters* of the sputa, and with the expulsive *force* which can be brought to bear upon them. Measures are therefore called *expectorants* which increase the absolute amount of sputum formed, which so modify its characters as to facilitate its expulsion, or which evacuate it with greater ease: the first and second kinds of expectorants acting upon the glands, the third kind upon the muscular structures. Regarded otherwise, the expectorants will be found sometimes to stimulate the respiratory centre, *e.g.* Ammonia and Ipecacuanha, sometimes to depress it, *e.g.* warm, moist air. But of greatest practical importance is the action of expectorants upon the circulation; and according to their stimulating or depressing influence in this respect, they are commonly divided into (1) *Stimulant expectorants*, and (2) *Sedative expectorants.* It must be clearly understood that "sedative" and "stimulant" in this connection refer *not* to the respiratory, but to the circulatory effect of the bronchial measures.

(*a*) **Stimulant expectorants** include Ammonia, Scilla, all the Volatile Aromatic oils, Oleo-resins, and Balsams enumerated above; Strychnia, Alcohol, Senega, warm liquid food, and moderate exercise of the body generally or of the chest.

(*b*) **Sedative expectorants** include Alkalies, Iodides, Antimony; Ipecacuanha, and Tobacco; warm, moist air; and warm, moist applications to the chest-walls.

If we wished to construct other groups of expectorants we might add:

(*c*) **Expectorants with a sedative effect on nerves.**—These are chiefly obtained by combining other expectorants with Opium, *e.g.* Scilla and Opium, Camphor and Opium, Ammonia and Opium, Ipecacuanha and Opium—all of which combinations are officinal, Antimony and Opium, etc. Warm drinks have the same effect.

(*d*) **Expectorants which alter the chemical composition of the sputa.**—This is a highly important group. Alkalies increase the alkalinity of the sputa, and at the same time the water of the bronchial mucus, and thus the liquidity of the sputa. They constitute a special class called the **Saline expectorants.** Sulphur, Iodine, all the Aromatic Oils, Oleo-resins, and Balsams, are excreted, as such, or as their products, along with an increased flow of mucus; and most of these, especially the aromatic substances, have an antiseptic, deodorant, and disinfectant effect on the secretion, and on the surface from which they are given off. They may be classed as the **Disinfectant expectorants.** The water of the bronchial mucus is increased in almost every instance of increased secretion, but specially by Alkalies, Iodine, and Antimony, which thus possess the valuable property of increasing the liquidity of the sputa. Lastly, Acids tend to diminish the amount of water, and thus the total amount of sputum, *i.e.* to "dry up" the secretion. They may be called **anti-expectorants.**

B. **Anti-spasmodics.**—These comprise a great variety of measures which have the common effect, directly or indirectly, of relaxing the muscular coat of the bronchi and the diaphragm. They are : (α) the various depressants of the respiratory branches of the vagus mentioned above (4*a*), such as heat, Iodides, Alkalies, etc. (β) The depressants of the other afferent nerves to the respiratory centre (5), especially warm applications to the chest-walls. (γ) The depressants of the respiratory centre itself (6)—Alcohol, Ether, Chloroform, Opium, etc. (δ) The direct nervo-muscular depressants—bronchial (4 *d*), such as Atropia, Tobacco, Amyl-nitrite, etc. ; and parietal (7), Conium, etc. All these substances are distinctly depressant or sedative ; but we have still another group of bronchial antispasmodics (ε), which are perhaps the most powerful of all, viz. some of the expectorants, such as Ipecacuanha, Senega, and Tobacco, which after momentarily increasing the spasm, cause a rapid and profuse flow of mucus from the bronchial wall, thus relieving the fulness of the vessels, provoking cough, and inducing expulsion of the cause of the spasm.

C. **Respiratory sedatives.**—These measures deserve a special name. The depressants of the afferent branches of the vagus to the brain, such as Opium, Ether, Chloroform, etc., not only act as antispasmodics and muscular depressants, *i.e.* prevent bronchial spasm, widen the tubes, and arrest cough, but also prevent or relieve pain and other distressing sensations referred to the respiratory organs. The most rational kind of pulmonary sedatives, however, are the expectorants above enumerated, in cases where the cause of the distress can be removed. A combination of the two classes will manifestly answer best in most instances.

III. PATHOLOGICAL RELATIONS.

The disorders and diseases of this system fall readily into two great classes, according as they affect (1) *the respiratory* *element* (*the red corpuscle*) and *its circulation*, or (2) the *nervo-muscular apparatus*, including the lungs and air-passages, the respiratory centre, and the afferent and efferent channels of communication. The first class were discussed in chapters viii. and ix.; the second will now be briefly noticed.

Circulatory, inflammatory, and degenerative changes comprise a large part of the diseases of the respiratory organs, such as bronchitis, pulmonary congestion, emphysema, and pleurisy, to which must be added new growths, whilst tuberculosis and syphilis occupy an intermediate position. Whatever their pathological nature, these diseases produce certain well-marked anatomical changes in the parts. The passages may prove to be obstructed, or actually occluded, by swelling of their mucosa, and by various products, such as mucus, pus, blood, or *débris*, which may be retained, inspissated, or possibly decomposed, thus irritating the nerves and vessels. Some of the bronchia may be entirely blocked, with collapse or consolidation of the corresponding lobules, and disturbance of the air pressure (emphysema) and blood pressure (hyperæmia) in the parts around. Portions of the lungs may be found either consolidated by pneumonia, or compressed by pleurisy, airless and functionless. Tracts of various size are frequently entirely destroyed by phthisis or gangrene. Hæmorrhage may occur in the alveoli or passages. The right heart frequently proves to be secondarily enlarged, from disturbance of the venous circulation, the viscera congested, and the serous cavities and extremities dropsical.

Whilst many of these anatomical changes are fortunately remediable, others are not so, and the efforts of the practitioner can only be directed to the relief of their symptoms, or, more correctly, their effects. Amongst these, disturbances of respiration, spasm, cough, expectoration, vomiting, and pain, alone require to be briefly noticed here.

Dyspnœa is a natural effort to increase oxygenation, and is due to stimulation of the respiratory centre in two distinct ways, viz. (1) by the imperfectly oxygenated blood circulating within it, and (2) by exaggeration of the impressions coming from the air passages and lungs. Obviously these two sets of causes are usually combined, since such anatomical changes as have been mentioned, interfere at the same time with the proper contact of the air and blood in the lungs, and irritate the pulmonary branches of the vagus. As a rule, dyspnœa is successful and highly beneficial; but unfortunately, if it fail to give relief, it tends to aggravate the distress.

Spasmodic dyspnœa, commonly called "asthma," is referable to sudden intermittent irritation of the vagus or centre.

Powerful reflex respiratory impulses are thus generated, and pass out to the bronchial muscles and the diaphragm, which are spasmodically contracted, interfering with the entrance of air.

Cough is essentially a physiological act, in itself highly beneficial, which may require to be encouraged and increased. Much more commonly, however, it is excessive, and becomes one of the most distressing symptoms demanding relief in disease of the chest. *Expectoration* may also be considered physiological within certain limits, but will require to be modified therapeutically when the quantity of the sputa is either excessive or deficient, or the quality rendered morbid by inspissation or decomposition. *Vomiting* is closely associated with cough and expectoration, which is not a remarkable circumstance, the two acts and their mechanisms being nearly allied to each other, as we saw in chapter iv.

Pains, and sensations of irritation, tickling, necessity to cough, "want of breath," tightness, oppression, suffocation, etc., are always exceedingly distressing; and, as they are among the chief complaints of patients, demand relief if it can be afforded.

IV. NATURAL RECOVERY.

Nature's method of meeting an extraordinary or otherwise morbid influence by *destroying* or *removing* it, is well seen in the case of the respiratory system. Coughing and sneezing are provisions for expelling any obstructing or irritating mass from the air-passages; and although apparently but of little service in preventing the most serious kinds of lung disease, they may really expel infective and other causes of morbid change much more frequently than we suspect, just as they guard the nose and the glottis from mechanically irritant particles.

The second great natural method of relief which is seen at work in this system is *reaction* or *counter-action*. The respiratory muscles respond to an obstruction in the passages by such an increase of the force and frequency of their contraction as will negative its action, and after a time they become hypertrophied if the obstruction persist. Dyspnœa or (better) hyperpnœa, is the result, a large reserve of muscular force and an almost unlimited power of hypertrophy sufficiently *compensating* for the diminished size of the air-passages and air-current, by increasing the depth and the frequency of breathing. The same principle is at work in the catarrh, that is the hyperæmia and secretion, set up in the air-passages or lungs on the entrance of a foreign body; the mucous, serous, or even purulent discharge—all evidences of different degrees of reaction—being essentially intended to counteract the irritant, as well as to carry it off and repair the damage it may have wrought.

The third natural provision against a morbid influence is the *removal of its effects*, whether the influence itself have been removed or antagonised, or not. Thus excessive secretions or other products of disease, which may in turn cause fresh obstruction of the passages, are removed by cough, expectoration, and vomiting; and the venosity of the blood which they cause is dispelled by hyperpnœa. Even spasm of the bronchi probably never causes death, because removed by the carbonic acid which accumulates in the blood in the second stage of asphyxia. Hæmorrhage from the lungs or nose frequently comes to the relief of over-distended veins, and removes the most urgent symptoms.

Vicarious action is yet another method of natural relief, of which abundant advantage is taken in respiratory disease; extraordinary muscles being called into play in hyperpnœa, the healthy parts of the pulmonary substance taking on increased function, and the skin and kidneys doubtless becoming more active as excretory organs.

In these several ways nature will frequently afford relief of respiratory disorders and diseases, whilst the cause of them is still at work, by removing or counteracting it and its effects. If she fail, and disease is established, recovery may still follow artificial treatment, the proper province of which is thus to assist, not to compel, much less to thwart nature. Even if organic changes have occurred, recovery may be effected by repair, as we see in inflammation of the lungs and pleura.

V. Rational Treatment.

The treatment of respiratory disorders if it is to be thoroughly rational, must be founded upon the considerations given in the four preceding sections. The student will understand that the treatment of the *disease* on which these disorders depend must be conducted at the same time; and that we are here concerned only with symptoms.

Dyspnœa.—The phenomena of dyspnœa strongly indicate the necessity of providing, by every possible means, for increased freedom and force of respiration—of assisting hyperpnœa by admitting as much air as possible into the chest. The air must be pure and mild, that is, abundant, fresh, warm, and moist. The muscles of respiration must be free to act upon the chest, and every available muscle of extraordinary respiration must be relieved from other employment and ready to be called into use: the shoulders must be raised, the chest freed from restraint and weight, in front, behind, and especially below (by adopting the sitting posture), and the arms must be capable of being fixed, if necessary. The circulation also must be spared by absolute rest and other measures.

Medicinal treatment must then be ordered, the first end to be secured being the rapid clearance of the respiratory passages of the products of disease. This is done by stimulating the natural provisions for relief, namely *cough and expectoration*, by means of expectorants. The cough must not only be induced or strengthened, but accompanied by a more profuse flow of watery mucus, so as to facilitate discharge of the sputa. Fortunately, most expectorants produce the second effect as well as the first; and we are left free to select our remedy, more from a consideration of its concomitant effect upon the circulation, *i.e.* according as a *sedative* or a *stimulant* effect is desired. Cardio-vascular sedatives, such as Antimony, Ipecacuanha, Iodides, and Alkalies, or a combination of these, will be preferred as expectorants in the first stage of inflammatory obstruction of the passages (*acute bronchitis*), salines being specially valuable as liquefying the mucus; whilst stimulants, such as Ammonia, Scilla, and the large Aromatic group, will be indicated at a later stage when the heart threatens to fail, or at any period in weak subjects. The Aromatics, such as Camphor, the Balsams of Benzoin, Tolu and Peru, Ammoniacum and Turpentine, also act as disinfectants, if the products have become purulent and tend to decompose. In every instance the value of warm liquid food must be taken advantage of.

Emetics may be employed to empty the respiratory passages when blocked by a comparatively large and solid mass, such as a croupous membrane; to empty dilated bronchial tubes when these and the lung-tissue have lost their elasticity from age and debility; and occasionally, when the necessary cough can no longer be induced on account of extreme weakness, and asphyxia is threatening. In the last-named case much danger attends such a depressing method of treatment; and in every instance comparatively mild and yet certain emetics must be selected for respiratory purposes, such as Ipecacuanha and Carbonate of Ammonia, or Sulphate of Zinc if these fail.

Posture is frequently of value in emptying the bronchi, or cavities communicating with them, of pus and other products. The body may sometimes be even inverted with success.

If asphyxia occur, artificial respiration must be carried out.

Dyspnœa may also be relieved by the abstraction of blood, or by its diversion from the thorax into the abdominal vessels, where its volume can be reduced by a free purge. This sometimes affords great relief at the commencement of acute bronchitis. Diaphoretics and diuretics are valuable under similar circumstances. But instead of reducing the volume of blood, or in addition to this means, we may prevent its accumulation in the lungs and right side of the heart by stimulant measures. Thus Carbonate of Ammonia not only irritates the nerves and glands of the bronchial mucosa, liquefies the secretion, and strengthens the respiratory centre, but is a powerful cardio-vascular stimulant, aiding the ventricular contractions, emptying the veins, and filling the arteries. Other circulatory stimulants which may not possess expectorant action are so far also indicated in respiratory distress, such as applications of mustard to the chest-wall and warm alcoholic drinks.

In dyspnœa from consolidation of the lung in acute pneumonia, *i.e.* from *diminished respiratory area*, the plan of treatment must be considerably modified. Here there is neither lack of air nor lack of blood; only they cannot come into mutual contact. The respiratory rate is greatly accelerated, and the air thus constantly changed; the cardiac rhythm is also accelerated, and the blood thus constantly renewed. The therapeutist appreciates this natural provision, and directs his measures to the support of the powers thus severely taxed: to maintain the strength of the respiratory muscles, and, most anxiously of all, to sustain the heart, by failure of which death is most likely to occur. Whilst, therefore, the strength is spared in every way, food is to be freely given with Alcohol, Scilla, Ammonia, and Digitalis; the atmosphere maintained as pure and fresh as possible; and the accompanying fever, which is attended by cardiac depression, steadily combated by suitable non-depressing measures.

Dyspnœa with spasm is so far to be treated on the same principles as other forms of obstructive dyspnœa, but the spasmodic element must be separately considered. Practically, by far the most rapid and powerful antispasmodics are, as we have seen, certain *expectorants*, including Tobacco, Ipecacuanha, etc., which provoke greater spasm, violent cough, and profuse watery secretion, thus instantly clearing the passages and relaxing the mucous membrane. A milder and equally rational class of antispasmodics to be employed in asthma are the direct depressants of the nervo-muscular structure of the bronchi, the chief of which are Belladonna, Hyoscyamus, Stramonium and their Alkaloids, Tobacco, and Lobelia, whether in solution or in the form of smoke. Conium is much less useful. Moist warm air or steam may be of great service as the only available remedy. Opium, Chloral, Cannabis Indica, and other narcotics, will frequently relieve spasm, but such powerful respiratory depressants are highly objectionable in threatening asphyxia. Nitrite of Amyl may instantly give relief, but the spasm may as quickly return; Nitre fumes suit some cases. Small doses of Spirit of Ether or Chloroform in solution are frequently most valuable, because so rapidly diffusible; and a mixture of Ammonia, Carbonate of Ammonia, Spirit of Ether, and Aromatics is one of the best combinations for general use.

Cough has been already referred to as far as it is to be encouraged, for the relief of movable obstruction and dyspnœa. When it is not only ineffectual but harmful, for instance when due to swelling, morbid growths, or purely nervous causes, it demands immediate relief. It cannot, however, be too much insisted on that the tendency of young practitioners is towards an abuse of this class of remedies, by prescribing them in a routine fashion for every case of cough, irrespective of its cause. Narcotics are powerful depressants of the respiratory centre, as well as of many other organs, including the heart; and, which is of equal consequence, they interfere with the reflection which originates useful cough and increased breathing, and ultimately aggravate the condition which they temporarily relieve. It is only when the cause of cough cannot be removed, that the irritability of the nervo-muscular apparatus may be safely reduced by respiratory sedatives, such as Opium, Chloroform, Ether and Chloral, Alcohol and Conium, according to circumstances, although warm moist air, warm liquid food, poultices to the chest, and acids or demulcents for the throat will often suffice to give relief. Several of these measures may be topically employed by insufflation, inhalation, gargling, or direct application, and when given internally they are advantageously combined with expectorants, which shall remove any movable irritant from the passages. When all but powerful opiates have failed to arrest protracted fits of coughing, as in phthisis, frequent small meals of warm liquid nutritious food, night as well as day, or pure alcoholic stimulants, will often give great relief. When the sputa are excessive, anti-expectorant measures may be demanded, and will consist in a fresh bracing atmosphere, dry simple food, the avoidance of alcohol, and the exhibition of Acids, Bitters, and probably Iron internally.

Hæmorrhage from the respiratory organs must be treated on general principles. Rest must be secured not only by bodily quiet, but by the reduction of the movements of the lungs to a minimum, by strapping the chest locally and recommending voluntary restraint of respiration and cough.

Pain and the other forms of *distress* in connection with this system are easily arrested by direct respiratory sedatives, such as Opium, but, as we have seen, not without considerable risk. The greatest discrimination must, therefore, be exercised in having recourse to these remedies, and the routine use of them is to be deprecated. Indirect measures, including the removal of the cause of distress, and external application to the chest, are alone to be employed if possible.

Substances which act upon the Respiratory System.

Stimulants of Respiratory Centre.	Stimulant (Circulatory) Expectorants.	Antiseptic Expectorants.	Respiratory Sedatives.
Camphora (at first) Belladonna Stramonium Hyoscyamus Strychnia Tabacum (briefly) Quebracho Acid. Hydrocyanic. (briefly) Physostigma (briefly) Ammonia Alcohol (briefly) Æther ,, Chloroformum ,, Antimonium ,, Ipecacuanha ,,	Scilla Senega Ammoniæ Carb. ,, Liquor Ammonii Chlor Strychnia Alcohol All Aromatics	Iodum Sulphur Benzoinum Styrax Camphora Cubeba Oleum Terebinthinæ Eucalyptus Creasota Acidum Carbolicum Pix Liquida Copaiba Balsam. Tolutanum Balsam. Peruvianum Myrrha Ammoniacum Anisi Oleum And other Aromatic Oils	Belladonna Stramonium Hyoscyamus Oleum Terebinthinæ Cannabis Indica Quebracho Amyl Nitris Acid. Hydrocyanicum Æthyl Iodidum Opium
Depressants of Respiratory Centre.	**Sedative (Circulatory) Expectorants.**	**Anti-Expectorants.**	**Anti-spasmodics.**
Antimonium Bromides Camphora (at last) Belladonna (at last) Stramonium ,, Hyoscyamus ,, Lobelia Tabacum (chiefly) Chloral Hydras Acid. Hydrocyanic. (chiefly) Aconitum Physostigma Conium Opium Veratria	Antimonium Ipecacuanha Apomorphia Alkalies Iodides Tabacum	Opium Acids Ferrum	Amyl Nitris Conium Potassii Iodidum Belladonna Stramonium Hyoscyamus Lobelia Tabacum Potassæ Nitras Opium Chloroformum Æther.
	Saline Expectorants.		
	Potassii Iodidum Potassæ Bicarb. ,, Citras Sodæ Bicarb. Sodii Chloridum		

CHAPTER XII.

THE NERVOUS SYSTEM.

THE therapeutical relations of the nervous system are as extensive as those of the whole body itself. Pain, for example, is constantly associated with local disease, and many of the most distressing diseases of the viscera are disturbances of nervous mechanisms. Here we must confine ourselves chiefly to the therapeutical relations of the higher nervous centres, representing sensation, consciousness, and voluntary motion, especially to the means by which we may relieve pain in general, produce unconsciousness, and induce sleep. The student must also clearly understand that we are approaching the therapeutics of the nervous system from the *physiological* side, *i.e.* the treatment of symptoms only. The treatment of the *pathological* processes, such as hæmorrhage, degeneration, syphilis, which constitute these diseases and cause these symptoms, is another and even more important part of the management of this class of cases, and one which falls under other heads.

I. PHYSIOLOGICAL RELATIONS.

Nervous tissue is a kind of protoplasm with highly specialised properties, which may be resolved into the one great property of displaying or discharging force when brought into contact with certain influences. We name this property *irritability ;* the influence which calls it forth, *an irritant ;* the act of calling it forth, *irritation.* If the effect be the display of more force than ordinary, we speak of the influence as a *stimulant,* and of the act or result as *stimulation.* If the effect of irritation be the display of less force than ordinary, we say there has been *depression*—that the influence is a *depressant.* Much discussion is still going on as to the nature of irritation, stimulation, and depression, but the points just indicated are clear enough for our present purpose.

Plan of the Nervous System.—The nervous system, though forming one continuous mass of nervous tissue, is built up of a number of *centres,* which are connected with an *irritable surface,* and with the *organs of force.* An impression made on the surface by an irritant is conveyed by an *afferent* nerve, or tract, to the centre; effects there some change upon the protoplasm; and either remains as potential energy, or flows out again through *efferent* tracts and nerves, as an *impulse,* to the organs of force—the muscles, glands, vessels, etc. This process is spoken of as *reflex action.* Nervous substance is, however, not simply irritable, or capable of being brought into action by an impression from without. It can also *originate* action. It is *automatic* as well as reflective. The automatic action of the higher centres is the basis of the emotions, of the intellect, and of the will, and is continually modifying the impulses flowing out of the reflex centres, and *vice versa*, by means of connecting fibres or tracts. In the same way the viscera, such as the heart, are innervated by automatic centres in the medulla or cord, and these are constantly influenced by impressions reaching them from all sides. The highest centres are in the convolutions; the simple automatic reflex centres in the basal ganglia, cerebellum, medulla, and cord—the whole constituting a series of successive centres, the central nervous system, joined to each other by tracts which associate or co-ordinate the impulses, whilst the outlying systems of ganglia, chiefly automatic in their action, are called the *sympathetic*.

Now we find, when we come to consider the action of drugs and other remedies on the nervous system, that certain of them affect one centre, some another; some afferent parts, others efferent or motor parts; that some drugs affect the lower centres only some the centres of emotion and intelligence only; and that others again interfere chiefly with the co-ordinating mechanism. We must therefore attempt to arrange the parts of the nervous system on something like a definite plan, before we can comprehend the action of drugs upon it.

Plan of the Nervous System.

I. The terminal irritable apparatus, on the surfaces of the body, and in the organs.
II. The afferent nerves.
III. The posterior of cornua of the cord.
IV. The convolutions.
V. The basal ganglia and cerebellum.
VI. The medulla oblongata.
VII. The antero-lateral tracts and anterior cornua of the cord.
VIII. The co-ordinating fibres between the different centres, especially in the cord, where they form definite columns.

If we were to add to this plan, we might put in the viscera with their nerves. These we have relegated to other chapters; and all that need be indicated at present is that most of the viscera are governed by centres in the medulla, cord, or cerebrum, an arrangement which is partly reflex; that the efferent nerves between the centres and the viscera are intimately connected with the sympathetic chain; and that the viscera have also intrinsic ganglia, by which their automatic action is chiefly carried on.

Sensation.—Sensation is a cerebral state, referable to an impression received through an afferent nerve. This generally originates at the periphery, more rarely in the afferent nerve or tract, but is in every case referred to the periphery. In this way an *impression* (peripheral) becomes a *sensation* (cerebral), and a sensation in turn may or may not travel onwards into a still higher part of the cerebrum, where it becomes a *perception*, a part of *consciousness*, a mental act. Of the various perceptions, common sensibility alone demands special notice here. The tissues and organs in health are sensitive, but not the seat of actual sensations. Very slight disturbance, however, is sufficient to arouse perception or consciousness of the condition of the organs, of which pain is an example, and we therefore assume the constant existence of a quiescent sense, called *common sensibility.*

Motion.—All movement may be said to originate as an *impulse* in a nervous centre, whence it is conveyed to muscles or muscular organs by *efferent* or motor nerves. Thus an impulse arising in the automatic action of the cerebral cells travels from the higher to the lower centres; here it joins the reflex impulse, proceeding by reflexion from these centres; and the mixed impulse courses through the motor nerves to a special *terminal apparatus*, say in a muscle, by which the motor nerve is brought into relation with the organ. Just as a perception in the cerebrum may be referable to a condition of any part of the afferent or sensory side of the nervous system, so muscular contraction may be produced by stimulation of any part of the efferent or motor side, from the convolutions to the muscle itself; and what is of special interest to the therapeutist, it frequently originates, wholly or in part, in stimulation of some part of the sensory side, reflected through the centres.

Consciousness.—This in a purely mental state, partly consisting of perceptions, and partly inseparably associated with the emotions, the intellect, and the will. Consciousness depends on the perfectness of the whole sensory apparatus, but from a practical point of view it may be considered to reside in the cerebral part of the same, *i.e.* in the convolutions, where it is readily reached by the therapeutist.

Sleep.—We cannot account perfectly for natural sleep, but we are probably right in associating it with diminished metabolism of grey matter, whether due to deficient blood supply, to impaired quality of blood, or to the molecular inactivity of the tissues following exhaustion. Sleep bears a definite relation to work, food, and the time of the day, and brings rest and refreshment to the exhausted system.

II. PHARMACODYNAMICS.

When we come to consider how far the nervous system is under our influence, we enter upon a field of enormous proportions, of which we can take but a few examples.

1. *Sensation.*—We have a remarkable power over both common sensibility and the special senses, increasing or diminishing their activity at our pleasure, by means respectively of *local stimulants* and *local anæsthetics.*

a. **Local stimulants.**—This name is given to a great and mixed group of agents, which increase common sensibility or common sensation so much as to cause *pain.* The majority of them act directly upon the *nerve fibrils* in the tissues, such as extreme heat, extreme cold (for a time), faradic electricity, and many drugs, including: Iodine and Bromine; Alcohol, Ether, and Chloroform, when the vapour is confined; Carbolic Acid and Creasote; volatile oils, *e.g.* Turpentine, Cajuput, Menthol, Thymol; acrid essential oils, *e.g.* Mustard and Mezereon, and Cantharides in the first stage. Mineral Acids and Ammonia; Metallic salts, such as those of Silver, Lead, Zinc, Antimony, Mercury, Arsenic, and Copper, also stimulate the nerves and cause severe pain, but not when supplied in sufficient strength to interfere markedly with the vessels and protoplasm of the part as caustics or astringents. Possibly some local stimulants act primarily upon the vessels, and many of them no doubt excite the circulation as well as the nerves. It must be carefully noted that the effect of local irritation on the sensory apparatus is really a *central* one. The sensation of pain, although it may be referred to the periphery, is a cerebral state. It therefore affords us a means of rousing the highest centres. What is even more important therapeutically, the whole of the impression conveyed from the irritated spot does not become converted into a painful sensation or act of consciousness. A portion of it, whilst traversing the grey matter of the spinal and medullary centres *en route*, disturbs these and causes reflex impulses, which rouse the muscles and viscera. In this way sensory, and especially *painful* impressions are powerful and readily available means of stimulating not only consciousness but the cardiac, vaso-motor, and respiratory centres, and through them the great viscera themselves. Thus the cold douche produces a sensation of cold referred to the part, rouses consciousness and so excites the respiratory centre as to cause the gasping movements of breathing familiar under the circumstances. In other words, *local stimulants may become powerful general stimulants.*

b. **Local Anæsthetics.**—Pursuing an exactly opposite line of action, we can readily diminish the sensibility of the origins of nerves until their power of receiving impressions is lost, and thus remove sensations by preventing the very contact of the influence with the nervous system. The measures which have this effect are called **local anæsthetics** (ἀν, *without*, and αἴσθησις, sensibility), or if pain be relieved, **local anodynes** (ἀν, *without*, and ὀδύνη, *pain*). Some of these agents directly depress the nerve fibrils, such as Belladonna, Aconite, Veratria, and Opium; and Ether, Alcohol, Chloroform, Carbolic Acid, Volatile Oils, and Cantharides, when their application is prolonged. Moderate cold, especially such as is induced by evaporation, is decidedly anæsthetic; and Ether, Spirits, Acetic Acid, Water, and various Saline solutions, *e.g.* of Chloride of Ammonium, possess this property. Prolonged or extreme cold directly reduces the functions of the nerves, causing first numbness, and then absolute anæsthesia. Warmth reduces, and extreme heat destroys, the irritability of the nerves. Other anodynes act partly or wholly through the vessels. Thus moderate heat relieves pain partly by dilating and relieving the blood vessels, and by increasing the blood-supply, the osmosis, and the migration of corpuscles in the tissues—an effect which is assisted by moisture, as familiarly seen in poultices. Cold partly acts by reducing excessive blood supply. The galvanic form of electricity often removes pain very quickly, probably by acting on the nerves, muscles, vessels, and even the metabolism of the part.

The influence of local anæsthetics and anodynes is not confined to the sensorium. With the arrest of sensation, the whole brain passes into a state of rest, and sleep readily occurs. The in-travelling impressions being reduced in strength, the spinal and medullary centres through which they pass, or into which they previously radiated, are no longer excited, and the action of the organs, such as the lungs and heart, becomes more automatic, and, as a rule, but not invariably, more quiet. Thus, as with local irritants, we possess in local anæsthetics and anodynes, a powerful means of influencing the functions of the highest centres, the visceral centres, and the viscera themselves. In other words, *local sedatives may become powerful general sedatives.*

c. All these measures act upon the peripheral structures. The *trunks* of the afferent nerves may also be affected so as to interfere with the convection of the impressions. Opium, and possibly other drugs, heat and cold, electricity, properly regulated pressure, and section or stretching of the nerves are different means of removing sensibility or at least pain.

d. The sensitive and perceptive *centres* in the cerebrum may be the seat of action of anæsthetics. Amongst the substances possessing this effect are Opium, Chloral, Chloroform, Ether, and Cannabis Indica, consciousness as a whole being affected by these measures, which are called **general anæsthetics, general anodynes,** or **narcotics**—a series of titles which will be presently noticed. Lastly, it will be observed that certain substances, such as Opium, arrest the afferent impressions *at every point*—at their formation, in the course of their conduction, and where they impinge upon the sensorium, that is, they act upon the sensory tract from one extremity to the other.

e. The special senses also can be directly influenced by various measures, including drugs. Local anæsthetics reduce the keenness of the sense of touch. Deafness and subjective noises are produced by Quinia, Salicylic Acid, and Alcohol. Santonin causes green vision. Taste is excited by a variety of influences which we have already studied; depressed and peculiarly disturbed by Aconite and other alkaloids.

2. *Motion.*—Our command of the motor side of the nervous system is greater than our influence over sensation, for the reason that motor parts can be acted on not only directly, but also reflexly through sensory parts, as we have just seen—local irritants exciting muscular movements, and local depressants arresting them.

a. Motor stimulants are specially interesting, as different drugs act on different parts of the motor apparatus from the cerebrum to the muscles. Alcohol, in moderate doses, increases the activity of the "motor" *convolutions*, and so probably do Chloroform and Ether for a very short time. *The medulla*, as the centre of the respiratory movements, is excited by Strychnia, Ammonia, Belladonna, and by small doses of Alcohol, Ether, and Chloroform. The *anterior cornua* of the cord (probably in association with the posterior cornua) are powerfully stimulated by Strychnia—convulsions being readily induced. Stimulation of the *motor nerve-trunks* can be used to excite the muscles by means of faradaic electricity.

Our most valuable motor stimulants, however, are applied to the *terminations* of the nerves, the *terminal apparatus*, and the *muscles* themselves, in the form of **local motor stimulants.** Strychnia acts also in this way. Electricity is in constant use for this purpose—as the faradaic, occasionally as the galvanic, current. Passive movements of the limbs, rubbing, shampooing, and douching, by rousing the local circulation and metabolism, are also means of preserving or increasing muscular nutrition and activity.

b. Motor depressants are a parallel series of agents. The motor convolutions are disturbed, depressed, and finally completely "paralysed" by large doses of Alcohol, Chloroform, and Ether, which completely arrest all voluntary movements. The motor functions of the *medulla* are so powerfully depressed by Opium, Chloral, Aconite, Conium, Physostigma and large doses of Alcohol and Chloroform, that death from poisoning by these substances occurs in this way. The *anterior cornua* of the cord are depressed by Physostigma and many less powerful drugs, which cause paralysis of the limbs through this channel. The same effect is produced by Conium and other substances, through depression of the *motor nerves*, not of the cord. The *motor nerve-endings* are remarkably under the influence of Belladonna; more, however, those of the involuntary muscles, with which we are not at present concerned. Galvanism is the most powerful local depressant of muscular activity, and is our ordinary means of producing this effect directly.

c. The *co-ordination of movement* is peculiarly interfered with by certain drugs, at any rate by Alcohol, which in considerable doses produces staggering gait, disturbance of the ocular muscles with double vision, thickness of speech, and awkwardness of the manual movements.

3. *Consciousness.*—From the very exalted position which it occupies in the system, consciousness is peculiarly amenable to a variety of influences at our command.

a. It can be *roused* by powerful, especially by painful impressions: for instance, the cold bath or douche; heat, or hot applications such as mustard to the surface; loud sounds, or powerful odours. Besides these, many drugs directly excite the brain, the **cerebral stimulants** and **deliriants**, such as Caffein, Camphor, Alcohol and Chloroform in the first stage; Opium, Chloral, and Cannabis Indica, in some individuals; Belladonna and its allies; Camphor, Salicylic Acid; laughing gas, etc.

The mental faculties are readily *disordered* by many of the same measures which increase consciousness, leading to laughing, crying, brilliancy of the imagination, increase of the appetites, confusion of the intellect, loss of control of the will, delirium in its many forms, and even convulsions. Alcohol, Opium, Cannabis Indica, Chloral, Chloroform, Camphor, and Belladonna, are specially active in producing these effects, which are seldom or never desired by the therapeutist for their own sake.

b. Equally valuable are our means of *reducing* consciousness, *or removing* it, and thus producing general anæsthesia, which, in appearance at least, closely resembles sleep, and is associated with suspension of all the other mental faculties. This effect may be secured by temporarily arresting the functions of the convolutions by means of drugs which *directly depress the nervous tissue of the convolutions*, such as Chloroform, Ether, Bichloride of Methylene, Alcohol in large doses, Chloral, and Opium. The Bromides, Caffein and Zinc, are valuable **cerebral depressants**, as they diminish reflex excitability, and thus promote rest of the nervous centres. Beyond these, a number of powerful substances, such as Aconite, and other vegetable and mineral poisons, produce a condition of coma with unconsciousness. The question arises, Which of the many active substances which possess this power are convenient and suitable for use? Careful observation has taught us that the *order of involvement of the various parts of the nervous system* by these substances—the line of march of their phenomena — differs widely with the different drugs. With some of them, such as Ether and Chloroform, the very first phenomenon is disturbance of the convolutions; and it is not until consciousness has been completely removed, that any serious depression of the medulla and its vital functions occurs. With others, for example, Opium and Chloral, the cerebrum and medulla appear to be simultaneously and equally involved; and before consciousness has been completely removed, the centres of respiration and circulation in the medulla may be dangerously depressed. A third set of nervous depressants have hopelessly paralysed the medulla before consciousness is much disturbed; such are Aconite and the irritant poisons. In selecting for use a drug which will remove consciousness, we entirely reject the third set. The first set, with Ether and Chloroform as their types, we retain as our **general anæsthetics**; the second set, including chiefly Opium and Chloral, are used under special circumstances, and are generally called **narcotics** (νάρκη, a deep sleep), or, as we have already seen, *anodynes*, pain destroyers.

The action of **narcotics** is very complex, extending from one extremity of the sensory side of the nervous system to the other, influencing also its motor side, and disturbing the sensory, motor, and metabolic functions of most of the viscera. In a person under the full influence of Opium, an impression can only be made with difficulty upon the peripheral nerves, or on the organs of sense; it is slowly and imperfectly conducted; and it is imperfectly perceived in the cerebrum. Thus cut off from all but the most powerful external impressions, and itself reduced in activity, the cerebrum is practically in the condition of deep sleep, characterised by unconsciousness. A fact of much greater importance, since unconsciousness is not of itself serious, however prolonged, is that it is accompanied by great depression of the medulla, that is, of the respiration and circulation, which, although sometimes to be turned to useful account, may readily prove injurious or even highly dangerous. We thus possess in narcotics a powerful means (1) of arresting perception, (2) of inducing sleep, and (3) of soothing the great vital functions, all of which may be of the greatest therapeutical service.

4. *Sleep.*—We possess many methods of promoting or producing sleep, which we call **hypnotics** (*ὕπνος*, sleep), or less properly "narcotics." Thus we may be able to secure mental calm, or the absence of noise and light, and to prevent or relieve pain or other disturbing impressions, such as attend indigestion, heart disease, and cough. Along with these *indirect hypnotics*, we may employ *direct hypnotics*, which act on the convolutions, either through the circulation or immediately upon the cells, in either way reducing nervous metabolism. Amongst medicinal hypnotics, the purest are perhaps the Bromides, which appear to bring the brain into a condition which favours the advent of natural sleep, rather than to induce it artificially, if any such distinction can be drawn. Artificial sleep is readily induced by the narcotics proper, including Chloral, Opium, and Alcohol, as well as general anæsthetics, all of which produce hypnotism amongst their other effects, and may be used for this purpose.

III. Pathological Relations.

We will now briefly consider some of the most common and typical disturbances of the nervous system. The organic diseases of this system are of great variety, including morbid states of the vessels, syphilis, degenerations, etc., but it is only the principal symptoms to which they give rise that will be noticed here for the purpose of illustrating the applications of the measures just discussed.

1. *Disturbances of Sensation: Pain.*—Pain is a familiar disturbance of common sensibility of a peculiarly distressing kind. As an expression of disease, whatever the tissue affected, pain always originates in some nervous structure between and including the periphery and the convolutions, but in every instance it is referred to the periphery. When pain is severe, it is accompanied by certain other phenomena, such as mental depression and restlessness, sleeplessness, weakening of the heart, indigestion, and other visceral disturbances. These may be in part effects of the morbid condition on which the pain also depends, but it is to be observed that pain is in itself a powerful depressant of the centres and viscera, just like local depressants of a pharmacodynamical nature.

2. *Paralysis.*—Loss of power, may be taken as an instructive illustration of motor disturbance. Comparably with pain, paralysis depends on injury or disease, of whatever nature, in some part of the motor side of the nervous system—the convolutions, basal ganglia, medulla, lateral column and other motor tracts, the anterior root of the spinal nerve, the nerve trunk, or the terminal motor apparatus in the muscle; occasionally it is distinctly a reflex effect of sensory disturbance; but the paralysis is always seen in the muscle. No class of disease teaches us more clearly the dependence of rational therapeutics upon an accurate knowledge of the anatomy, physiology, and pathology of the parts affected.

3. Side by side with pain and paralysis respectively, there are to be ranged many allied conditions. Thus, allied to pain, and depending like it on disturbance of some part of the *sensory* tract, are the sensations of numbness, coldness, excessive sensibility to touch (hyperæsthesia), excessive sensibility to painful impressions, such as pin-prick (hyperalgesia), and the various disturbances of the special senses; loss of the sense of touch (anæsthesia), loss of the sense of pain (analgesia), and alteration or loss of the organic sensations relating to the stomach, bowels, heart, bladder, etc. In the same way we place beside paralysis other motor disturbances, whether in the form of increased muscular movements—chorea (St. Vitus's dance), tremors, spasms, convulsions, or disturbed movements of the viscera, as of the heart, intestines, uterus, vessel walls, etc.; and we say that they may be due to disease of any part of the motor tract from one extremity to the other, or of some part of the sensory area of the nervous system by reflection through the centres. Reflex spasms, convulsions, and visceral disorders, are especially common.

4. Disturbances of *consciousness*, and of the other higher faculties of the nervous system, include unconsciousness or insensibility, delirium or excitement, and the great class of "diseases of the mind" constituting insanity. Unconsciousness may be the result of injuries to the head; of interference with the blood-supply to the brain, familiarly seen in fainting; of interference with the supply of air to the brain, as in asphyxia; or of poisons, such as alcohol and opium. To these causes we may add organic diseases of the brain, and indeed most diseases just before death. Delirium and other forms of excitement are phenomena of many diseases, and of the action of a variety of poisons, and must be regarded as associated, both as effects and causes, with excessive nervous metabolism, leading rapidly to exhaustion.

5. *Sleep* is most commonly *deficient or absent* when it calls for

treatment; very frequently disturbed; sometimes excessive. Pain is the common cause of insomnia, but sleep may be prevented or broken by cerebral exhaustion (? vascular paralysis) from overwork, by mental anxiety or distress, by oppressed or breathless feelings in the chest, by dyspeptic troubles, and by other distressing sensations, such as irritability of the bladder, spasms of the muscles, and itching of the skin. Sometimes sleeplessness appears to be idiopathic, *i.e.* a disorder *per se.* Excessive *sleepiness*, or continual tendency to sleep, is a result of the retention and circulation in the system of urea or allied products which have not been sufficiently excreted by diseased kidneys; and drowsiness, to a less degree, is a frequent symptom of anæmia, or of disturbed metabolism in the liver, as we saw in the tenth and eleventh chapters. Certain articles of diet, especially alcohol in the form of beer, produce the same effect.

IV. NATURAL RECOVERY.

As the nervous system is the most impressionable of all the tissues, so it seems to possess the power of recovery most quickly and most perfectly from conditions of disorder, when the causes of these are removed. Thus, pain may instantly disappear upon a slight change of temperature, on the application of a weak electrical current, with the alteration of the chemical reaction of the part, or in consequence of the contact with it of a minute quantity of some drug—any of which means will have sufficiently restored its normal condition, or counteracted the abnormal state which gave rise to the distress. In no department of pathology, therefore, is the indication clearer, and encouragement greater, to step in and assist nature by pharmacodynamical measures. Unfortunately, here, as elsewhere, there are certain *limits* to treatment. The disorders of the nervous system to which we have alluded, such as paralysis, spasm, pain, anæsthesia, and disturbances of consciousness and of the mind generally, are too often but the phenomena or symptoms of organic disease of the delicate nervous structures. Scarcely less hopeless is the prospect of curing certain functional disorders of the nervous system, without discoverable anatomical cause, such as epilepsy and hysteria. But even in both these classes of cases, many of the most urgent symptoms, and the severity and frequency of others, can be mitigated by the measures which we have just reviewed, as we shall now attempt to show.

V. THERAPEUTICS.

In drawing a rational conclusion from what we have studied under the four preceding heads, we approach, as we proposed, the consideration of the therapeutics of the nervous system chiefly from the point of view of symptoms.

1. *Disturbances of Sensation: Pain, and the use of Anodynes.*—Our review of the physiological and pathological relations of pain leads us to its rational treatment. We must discover, first, its morbid cause, and secondly its exact physiological significance, and apply our measures accordingly.

The scientific use of anodynes, as we have already suggested, is founded upon correct diagnosis. It will frequently be found that when the cause is known, pain can be removed without the employment of any nervine remedy, and in every instance this treatment should be entertained or attempted. An abscess will be relieved by the knife, headache by purgation, syphilitic periostitis by Iodides. We thus discover a great group of measures which, whilst they are not anæsthetics, are *indirect anodynes*, because they attack the pathological cause of the pain, and do not immediately act upon nervous tissue. *For practical purposes*, anodynes may be classified into (1) *indirect anodynes;* (2) *direct anodynes which act on the peripheral nerves only;* and (3) *direct anodynes which act on the centres as well as the periphery.* In many instances these may be combined.

a. Indirect anodynes are necessarily a heterogeneous group, and include surgical operations of every kind, which are amongst the readiest and most radical of all, *e.g.* opening abscesses, simple physical protectives, such as ointments and oils in burns; poultices and warm fomentations, and cold in various forms.

Local irritants, such as mustard and blistering agents, which cause much pain at first, may become local anodynes by producing an effect which is called *counter-irritation*. We shall discuss fully this class of remedies in chapter xv., but we may for the present refer their action to exhaustion of the irritability and conductivity of the local nerves, to dilatation of the vessels and relief of anæmia, and to some influence on the nervous centres corresponding to the affected part. Another powerful natural group of local anodynes, which are chiefly indirect, but partly also direct, in their action, consists of the essential oils, such as Turpentine, Camphor, and the Oils of Cloves, Mint, etc. These have a complex action: they destroy the organisms of disease by virtue of being antiseptic; they dilate the vessels, causing redness and heat; and they depress the peripheral nerves after temporary pain. Certain allied artificial products possess a similar indirect and direct anodyne power, *e.g.* Carbolic Acid and Creasote. Besides these *local* indirect anodynes, we possess an unlimited number which act *generally*; as many, indeed, as the remediable causes of pain. Thus, headaches may be relieved, under different circumstances, by any of the local measures just enumerated, or by such diverse general remedies as purgatives, Quinia, Iron, Iodides, and Alcohol, quite independently of the direct anodynes which we may consider it necessary to apply.

b. Local Anodynes.—When treatment directed to the cause of the pain fails or is insufficient, we must next attempt to reduce the irritability of the nerves by local means. Direct *local anodynes* may now be rationally employed. Thus in neuralgia, constitutional treatment must be combined with the application of a local anodyne sufficiently powerful to interfere with the reception and conduction of impressions. We therefore employ Aconite, Belladonna, Opium, the confined vapour of Chloroform, Alcohol, or Ether, the Volatile Oils, Carbolic Acid, Creasote, heat (which must often be extreme), extreme cold, the continuous current, or local nervous irritants. Most of the drugs mentioned are applied in the form of liniments, lotions, or ointments. Opium may be administered by the endermic or hypodermic method, the former being now almost entirely superseded by the latter, which is by far the most valuable of all anodyne measures, from the readiness with which it can be given, and the rapidity and completeness of its action. Alcohol or Chloroform may be poured on lint, and evaporation prevented, or rubbed on the part and covered.

c. General Anodynes.—When pain is very severe, sleep impossible, and the whole system distressed and disordered, direct general anodynes are demanded. The most useful is Opium or Morphia, which may be given in a great variety of forms, and by several channels, the most ready and powerful of all being the hypodermic method. Chloral, Butyl-chloral, and Cannabis Indica, are other general anodynes in use, but are greatly inferior to opium. The narcotic or hypnotic effect of these anodynes is taken advantage of, as a rule, by prescribing them at the usual hour of sleep.

Where the pain is unbearable, and relief must be not only complete but instant, even these powerful anodynes may be unavailing. In such cases *general anæsthetics* must be employed: the patient must be put under the influence of Chloroform or Ether. Such are the pains of labour, or of the passage of calculus, the pain attending the reduction of a dislocation or a severe surgical operation. Consciousness is quickly abolished, kept in abeyance, and allowed to return when the cause of the pain has ceased. The necessity for such powerful remedies in some instances of pain will impress on the student the importance of sparing the nervous system, and the viscera which are reflexly depressed along with it, in every case of pain.

Food and stimulants are, as a rule, urgently indicated in protracted pain.

2. *Loss of Common Sensibility.*—Neither this nor the allied condition of loss of touch (*anæsthesia*) very often calls for treatment, and the large number of nerve irritants which we possess in the Acids, Metallic Salts, Mustard, etc., are seldom used for this purpose. Pyrethrum is sometimes given in anæsthesia of the mouth.

3. *Paralysis.*—The rational treatment of paralysis will depend entirely on its nature, and the seat of its cause; and this, as in the case of pain, must be ascertained as accurately as possible. If the lesion be cerebral, general remedies must be directed to relieve the pathological state, such as Mercury in syphilis, cardiac measures in vascular rupture, and so on. Rest of the mind, *e.g.* by Bromides, will be all important. There is no indication, as a rule, to increase the activity of the damaged centres, except after a time by the use of the will; on the contrary, all cerebral stimulants, such as alcohol, are better to be avoided. In paralysis from disease of the cord, the same general system of treatment is to be followed, but Strychnia may be tried as a direct stimulant of the affected part, sometimes with success. In paralysis due to injury or disease of the nerve trunks or peripheral nerves, the cause must be carefully searched for and if possible removed, *e.g.* tumours. The local injection of Strychnia appears to benefit some cases. In every kind of paralysis, local treatment must be carried on along with general, and consists chiefly in exercise of the terminal nerves and muscles by electricity, friction, and passive movements, with the view of sustaining the local circulation and nutrition until the centres shall have been restored.

4. *Excessive Motor Activity*—in the form of spasm, tremors, and convulsions—being generally due to peripheral irritation reflected through the centres, is rationally treated by removal of the cause. The convulsions of children, for instance, are generally to be treated by stomachics and purgatives; the spasms of adults by carminatives. But in many cases it may be necessary also to employ remedies which depress the reflective centres, such as the Bromides and Opium. When the cerebrum is believed to be the seat of disorder or disease attended by these symptoms, *e.g.* epilepsy, the Bromides are of great service, whilst tetanus, hydrophobia, and other spasmodic diseases with better defined organic causes in the cord and medulla, may be rationally treated by Physostigma and Chloral. It cannot be said, however, that much success rewards such treatment, possibly because employed, as a rule, too late. When the spasm appears to be due to purely local

causes, Belladonna and Conium are often of use, *e.g.* in chordee, spasmodic asthma, and laryngismus. The continuous battery current and counter-irritants relieve painful spasm of the voluntary muscles. Lastly, Opium again is a most powerful antispasmodic for general use.

5. *Consciousness* may be said to demand temporary *removal*, in anticipation of the excessive pain and anxiety attending operations. The general anæsthetics in common use are Ether and Chloroform, the selection and use of which are fully described under their special therapeutics. Conditions of *excitement*, such as delirium and mania, are to be met by two sets of remedies, which must always be combined—viz. first, cerebral depressants, such as Opium, Chloral, Hyoscyamus, Bromides, and, if necessary, Chloroform; and secondly, general nutrients and stimulants, chiefly in the form of abundant food, and possibly a certain amount of alcohol. Judicious moral treatment is an indispensable accompaniment.

6. *Loss of consciousness* appears to require and receive treatment in cases of fainting, drowning, accidents to the head, etc., but the great centres of respiration and circulation are the real objects of our anxiety. They have been depressed along with the convolutions, and must be restored to activity if life is to be preserved. Restorative measures include the re-establishment of the general and cerebral circulation by the recumbent posture and cardiac stimulants, and of respiration by artificial chest movements and abundance of fresh air. Local nervous irritants such as cold affusion, flagellation, or mustard applied to sensitive parts, powerful odours, and Ammonia, must each or all be employed.

7. *Disorders of Sleep* will be rationally treated by pursuing the course suggested by our previous considerations. *Insomnia* may be met by the many indirect and direct hypnotics. In every instance full advantage must be taken of the indirect group. Bromides are indicated when the cerebral circulation is excited by overwork; and Chloral may be combined with it. When pain is present Opium only will induce sleep. When there is much mental distress Opium is again necessary, and Alcohol at bedtime may be invaluable. In every instance the time of administration of hypnotics must be carefully ordered. Further, it must never be forgotten that the narcotics, including Opium, Morphia, and Chloral, are all powerful depressants of the respiration, circulation, and excretions, and may produce disastrous results, whilst they afford the temporary advantage of sleep.

SUBSTANCES WHICH ACT ON THE NERVOUS SYSTEM.

LOCAL STIMULANTS.

Alcohol
Æther
Chloroformum
Ammonia (at first)
Acid. Carbolic. (at first)
Creasotum (at first)
Oleum Terebinthinæ
Veratria (at first)
Cantharis (at first)
Potassa Caustica
Argenti Nitras
Plumbum
Zinci Chloridum
Hydrargyrum (at first)
Iodum (at first)
Bromum
Arsenicum
Antimonium
All Aromatic Oils
 ,, Oleo-resins
 ,, Resins
 ,, Balsams
Acrid Oils.
Mineral Acids.

LOCAL ANÆSTHETICS; LOCAL ANODYNES.

Belladonna
Stramonium
Hyoscyamus
(?) Conium
Bromides
Opium
Alcohol
Chloroformum (chiefly)
Acid. Carbolic. (at last,
Creasotum (at last)
Acid. Hydrocyanic. Dil.
Sodæ Bicarb.
Creta
Aconitum
Ol. Terebinthinæ
Pix
Veratria (at last.
Cantharis
Zinci Oxidi (at last)
Iodum (at last)
Local Refrigerants.

LOCAL ANÆSTHETICS; LOCAL ANODYNES (continued).

Bismuthum
All Aromatic Oils.
 ,, Oleo-resins
 ,, Resins
 ,, Balsams

CEREBRAL STIMULANTS AND DELIRANTS.

Belladonna (at first)
Stramonium (,,)
Hyoscyamus (,,)
Tabacum
Santoninum
Camphora
Alcohol (at first)
Chloroformum (briefly)
Coffee (at first)
Guarana ,,
Theobroma ,,
Cannabis Ind. (at first)
Lupulus (at first)
Opium (at first)

CEREBRAL DEPRESSANTS.

Bromides
Acid. Hydrocyanic. Dil.
Coffee (at last)
Tea (at last)
Guarana
Theobroma
Ol. Terebinthinæ
Potassium
Lithium
(?) Argentum
(?) Cuprum
Zincum
Arsenicum (?)
Antimonium

HYPNOTICS.

Bromides
Narcotics
General Anæsthetics.

SUBSTANCES WHICH ACT ON THE NERVOUS SYSTEM (*continued*).

NARCOTICS.	STIMULANTS OF MOTOR CENTRES OF CORD.	DEPRESSANTS OF MOTOR CENTRES OF CORD (*continued*).	DEPRESSANTS OF MOTOR NERVES AND NERVE ENDINGS.
Opium (at last)	Nux Vomica and Strychnia	Gelsemium	Conium
Chloral Hydras	Chloroformum (at first)	Opium (at last)	Belladonna
Belladonna (at last)	Æther (at first)	Potassium	Stramonium
Stramonium	Ergota (at first)	Lithium	Hyoscyamus
Hyoscyamus	Opium (briefly)	(?) Argentum	Amyl Nitris
Alcohol (at last)	Ammonia	(?) Cuprum	Acid. Hydrocyanic. Dil.
Cannabis Ind. (at last)		Zincum	Opium
Lupulus (at last)		(?) Arsenicum	
GENERAL ANÆSTHETICS.	DEPRESSANTS OF MOTOR CENTRES OF CORD.	STIMULANTS OF MOTOR NERVE ENDINGS.	REFLEX-MOTOR STIMULANTS.
Nitrous Oxide	Physostigma	Strychnia and Nux Vom.	Strychnia
Chloroformum	Camphora	Opium (briefly)	Counter-irritants
Æther	Bromides		Carminatives
Bichlor. of Methylene	Alcohol		Ammonia
Dichlor. of Ethidene	Chloroformum (at last)		
Æthyl Bromidum	Æther (at last)		
	Amyl Nitris		
	Sodii Nitris		
	Ergota (at last)		

CHAPTER XIII.

THE KIDNEY.

The position which the kidney occupies in the circle of the great physiological systems gives a special character to its diseases, and to the actions and uses of remedies in connection with it. The series of vital processes which commences with the admission of food, air, and medicines, ends chiefly with the excretion of urine. Digestion, assimilation, sanguification, metabolism, circulation, and respiration, all, therefore, affect the activity of the kidney. This is chiefly due to the fact that the kidney does not itself form the urea, uric acid, pigments, salts, and water which form the bulk of the urine —that these bodies reach it by the blood, and it has but to sweep them from the circulation. This dependent position of the kidney is of great interest to the practical therapeutist. Clinically, the condition of the urine is a key to the manner in which the various viscera are discharging their functions; pathologically, we often find in other organs the cause of renal disease; and pharmacologically, we discover that if we wish to affect the composition of the urine and the activity of the kidney, we must, in many cases, direct our measures to the digestive organs, the heart and the vessels.

Conversely, the kidney makes its influence felt backwards upon the other organs. Disturbance of the renal function quickly tells upon the blood and viscera. We saw this under the heads of the liver and metabolism, and noted how quickly the retention of waste products checked functional activity, like ashes choking out a fire. As striking a relation exists between the kidney and the organs of circulation. Thus the practitioner, adopting the inverse order of investigation, estimates the condition of the kidney by the pulse, bowels, and appetite; the pathologist finds in the enlarged heart and ruptured vessels of the brain the outcome of disease of the renal glomeruli; and the pharmacologist relieves the blood pressure or the liver by measures directed to the kidneys. These preliminary considerations will prepare us for the systematic discussion of this complex subject.

I. PHYSIOLOGICAL RELATIONS.

The source of the urine is believed to be certainly double. The bulk of the *water* is excreted in the Malpighian bodies, being squeezed from the glomerulus into the capsule by the blood pressure within the former. The excreting force is determined (1) by the pressure of the blood entering the glomerulus by the afferent vessel, and (2) by the resistance to its flow through the efferent vessel; whilst the freedom of filtration depends upon the fact that the uriniferous tubules have a free outlet, and thus present but little obstruction to the entry of water into their channel.

The size of the renal vessels is regulated by vaso-motor nerves, coming chiefly from the splanchnics, which derive their renal fibres from the medulla oblongata, in part at least through the first thoracic ganglion. The spot in the fourth ventricle which thus presides over the vessels of the kidney is a *centre*, *i.e.* it receives impressions through afferent nerves, and sends impulses through efferent nerves to the kidneys. Thus powerful emotions will disturb the flow of urine, and the temperature of the surface of the body affects the amount of urine secreted, partly at least reflexly.

The *solid constituents* of the urine—urea, uric acid, and their allies, and many of the salts, dissolved of course in a small quantity of water—are probably separated from the blood by the cells of the convoluted tubules. The activity of the renal epithelium no doubt depends, like that of the salivary glands, upon an inherent secreting force of its own, probably controlled by trophic nerves; upon the activity of the circulation; and especially upon the quality of the blood. We have already seen that the materials which the blood conveys to the kidney for excretion will depend upon the activity of all the bodily functions, and we will not return to this subject except with respect to *the influence of digestion and assimilation on the urine.* During gastric digestion a quantity of acid is withdrawn from the blood to furnish the gastric juice, and this loss of acidity in a fluid already alkaline makes itself felt in the urine, which soon becomes less acid, or even alkaline. This reaction increases when absorption begins. Water and salts enter the blood; augment still further the alkalinity of the urine, the salts being chiefly alkaline, and the total volume of the blood, and thus of the renal secretion, is increased; the arterial pressure rises. Finally, the products of the action of the liver, lungs, and other metabolic organs, upon the peptones and carbohydrates (urea and its allies) also enter the blood and appear in the urine, in comparative excess. This condition of the urinary function and urine, consequent on a full meal, gradually declines. The excess of water escapes; the alkaline salts are voided; the excess of urea and uric acid disappears; and therewith the general characters of the urine change. By the end of three or four hours from the admission of food, the urine is again moderate in amount, more acid, and clear, an increase of acidity following the previous reduction.

II. PHARMACODYNAMICS.

The preceding considerations prepare us for the conclusion that what power we may possess over the excretion of urine will be exercised, as far as its water is concerned, chiefly through the circulation; as far as the solids are concerned, chiefly through the blood. These points must be separately studied.

1. *Measures for Increasing the Volume of Urine.*—The amount of water, that is, the volume of urine which is excreted from the glomerulus, may be increased by **diuretics**, the effect being called *diuresis* (διὰ through and οὖρον the urine). This may be accomplished in various ways:

(*a*) *By raising the pressure in the arteries generally, including the renal*, whilst the pressure in the veins is constant. This is most easily effected by temporarily increasing the amount of water in the system by drinking; by raising the force or the frequency of the heart, or both, by Alcohol, Digitalis, Scilla, Ammonia, and Scoparium; or by constricting the peripheral vessels through the vasomotor system, *e.g.* by cold to the surface, Digitalis, Scilla, or other vascular stimulants. These measures are called **cardio-vascular diuretics.**

(*b*) *By dilating the renal arteries*, so that the quantity of blood within them is increased, whilst the pressure in the arterial system generally, and the resistance in the renal veins, remain unchanged. This method of increasing the amount of the renal water may be carried out by acting on the vaso-motor system of the kidney either locally or centrally. Local depressants of the renal nerves include Digitalis and Scilla in the second stage; Spirit of Nitrous Ether; all Volatile Oils and Resins, such as Turpentine, Juniper, Copaiba, Hops, Savin, Cantharides, Camphor, etc.; Alcohol, Belladonna, Aconite, Nitrates, and Nitrites. Central renal vascular depressants are chiefly or solely emotional impressions which are not available as pharmacodynamical means. A powerful reflex dilator of the renal vessels is cold to the surface. Such measures are **local vascular diuretics.**

(*c*) *By combining the two previous means*, when still more profuse diuresis will be the result. This occurs in the second stage of the action of Digitalis and Scilla, and in the application of cold to the surface.

2. *Measures for Diminishing the Volume of Urine.*—The volume of urine might be diminished by employing the opposite set of influences to those just described. These are obscure, however, and of less therapeutical interest; and the student may be left to work out the different systems for himself.

3. *Measures affecting the Secretion of Urinary Solids.*—The

activity of the *renal epithelium, i.e.* the excretion of solids and of a certain amount of the water, may be modified by influences of two classes:

(*a*) *By measures and conditions which affect the renal cells through the composition of the blood in general.*—Of these, the state of digestion, including the selection of food, is the most important. The quantity of food; its richness in proteids, carbohydrates, and salts of different kinds; the relative amount of work thrown upon gastric or acid, and duodenal or alkaline digestion; and the vigour of hepatic metabolism, as determined by so many causes, including exercise, oxygenation, and the use of drugs—may all be made use of by the pharmacologist in altering the composition of the urinary solids.

One of the most easy and important of these alterations is in the *chemical reaction* of the urine. The natural acidity of the urine can be *increased* by excess of proteids, sugar, and starch, by deficiency of water, by certain wines and spirits, by Salicylic and Benzoic Acids, and by an excess of Tartaric and Citric Acids. The mineral acids have an insignificant or even negative power on the acidity of the urine, a fact which is to be carefully noted. Sulphuric Acid is excreted by the kidneys (in part), but as neutral sulphates; Hydrochloric Acid as neutral chlorides, Phosphoric Acid as phosphates; Nitric Acid is believed to increase the ammonia in the urine by decomposition in the blood, so that it may have an alkaline influence; and Tartaric, Citric, and Acetic Acids in combination with Alkaline bases, escape as Alkaline Carbonates.

On the other hand, we possess abundant and powerful means of rendering the urine *alkaline*. Amongst foods, the most effective in this direction are fruits, milk, and fish, as they throw into the blood a quantity of Alkaline Citrates, Tartrates, Acetates, Carbonates, and Phosphates, which are directly or indirectly excreted by the kidneys. Amongst drugs, the whole group of Alkalies and Alkaline Earths have an alkalinising effect on the urine, excepting Ammonia, which is completely broken up in the system. Thus the alkalies are entirely unlike the mineral acids in exercising a powerful and available influence on the reaction of the urine.

(*b*) *By measures which affect the renal epithelium specifically.* Whatever may be their alkalinising value in the blood, certain substances have a special influence on the urine by *specifically acting upon* the renal cells. Thus Potash and Soda possess equal values as alkalinisers of the *blood*, but potash will much more powerfully and quickly neutralise the acidity of the *urine*, because whilst Soda is excreted partly by the bile and bronchial mucus, or locked up in the system as the neutral chloride of sodium, Potash stimulates the renal epithelium, which excretes it as the carbonate. Soda does, however, possess a degree of specific action on the kidney, especially its Phosphate and Acetate. Lithia closely resembles Potash in this respect; Ammonia, although not an alkaliniser, has a similar influence; and Magnesia and Lime are distinctly stimulants of the renal epithelium, as is well seen in some natural mineral waters. Now, in passing through the cells, these salts necessarily carry with them a certain amount of water from the venous plexus around the tubules, and if abundant, actually produce diuresis. They thus furnish us with another group of diuretic measures, which we call the **saline diuretics**, chiefly alkaline in their influence on the blood and urine, but at the same time independently active as specific renal stimulants. Let it be carefully noted that the saline diuretics do not, as far as we know, directly affect the renal circulation; but that we possess in them an indirect means of influencing the venous plexus around the tubules, and thus the whole renal circulation and the general blood pressure, especially the pressure in the veins.

Another great group of natural substances in the materia medica have a specific effect on the renal epithelium, namely, the Aromatic Oils, Oleo-resins, and Balsams. The chief of these are Turpentine, Juniper, Copaiba, Cubebs, Cantharides, and Hops; whilst Jaborandi, Alcohol, Aconite, and many more act partly in the same way. All these substances, either as such or after decomposition, are excreted (in part) by the renal cells, and carry with them, like salines, so much water, besides dilating the renal vessels, as we have already seen. The degree in which the different members of this great class act upon the renal cells varies widely, however: thus, Juniper and Copaiba are powerful diuretics, greatly increasing the urinary flow, whilst most of the others have but little effect on the volume of urine, possibly because their action on the renal vessels, which accompanies their action on the cells, does not favour the escape of fluid. Thus Turpentine and Cantharides, two most powerful renal stimulants, sometimes diminish, sometimes increase, the urinary water, and may even cause hæmorrhage from the glomerulus.

Opposed to these renal stimulants are *renal sedatives or depressants*, which appear to diminish directly the activity of the renal cells, when they reach them through the blood. Morphia has this effect, and possibly quinia (?) and other substances.

III. PATHOLOGICAL RELATIONS.

The disorders of the renal functions, which will be taken by us to illustrate the application of the measures just noticed, may be summarised as follows:

1. *Disorders of the fluid secretion referable to the general blood pressure.*—(*a*) *Diminution of the general arterial pressure*, which is generally referable to heart disease, leads to marked disturbance of the urinary flow. We saw under the head of the circulation (page 472) how dilatation of the heart lowers the pressure in the arteries and raises it in the veins, *i.e.* lowers it in the afferent vessel of the glomerulus, and raises it in the efferent vessel, thus causing *congestion of the kidneys.* The urine in this class of cases contains albumen and blood proceeding from the engorged veins; it falls in quantity in consequence of the fall in the arterial pressure, and of obstruction in the tubules, which become choked with fibrinous casts; and the total excretion of solids is diminished, as the result of retardation of the blood current.

(*b*) *Increase of the general arterial pressure* is associated with that form of chronic disease of the kidney known as the "Granular or Contracted Kidney." Here the urine is very abundant, probably reaching several times its normal volume, very light in colour and weight, and may contain a trace of albumen. The tension of the radial artery is high; the left ventricle is hypertrophied; and the patient often dies of secondary dilatation of the heart, or of rupture of an artery in the brain. As far as the kidney is concerned, the condition is one of constant pathological diuresis.

2. *Disorders of the fluid secretion, referable to the local blood pressure.*—(*a*) *Certain nervous conditions* disturb the pressure in the kidney by causing contraction or dilatation of the renal vessels, and thus modifying the amount of urinary water. Such a condition may be either central or local, direct or reflex. Thus hysteria is attended by alternately profuse and deficient flow of urine. Disease of the medulla and its neighbourhood may give rise to profuse diuresis (*diabetes insipidus*), which has been traced in other cases to disease of the renal nerves. Reflexly, the chief cause of disturbance of the renal secretion is injury or disease of the prostate or urethra, which may even lead to fatal suppression.

b. Morbid conditions of the blood-vessels of the kidney, such as disease of the glomeruli, arteries and veins, which constitute one of the elements of Bright's disease, produce a variety of disturbances in the volume and constitution of the urine, according to their exact seat and degree. Pressure on the trunks of the renal vessels by abdominal enlargements may also cause serious disturbance of the renal circulation, with albuminuria, hæmorrhage, or even suppression of urine as the result.

3. *Disease of the secreting epithelium.*—This constitutes another element of Bright's disease. The diseased cells fail in function, choke up the tubules, press upon the venous plexus, and thus give rise at once to stagnation of the blood current and resistance to the filtration of water through the glomerulus. The clinical phenomena of this condition (commonly called the Large White Kidney), are very definite. The urine falls in volume; the solids are absolutely diminished, but relatively increased, so that the specific gravity is high; and in their place there appear albumen, probably derived directly from the venous plexus, blood from the same source or from the glomeruli, and casts formed of diseased cells, fibrin, etc. The blood becomes poisoned by retention of urea. The systemic vessels become diseased, and the heart hypertrophied; and the blood-change and cardio-vascular disease together lead to marked breathlessness, and to escape of the watery parts of the blood into the tissues and serous cavities, constituting renal dropsy.

4. *Rise of pressure within the uriniferous tubules* is a serious cause of complete arrest of the secretion. This is one of the effects of fulness of the venous plexus, and of epithelial accumulations in the tubes, already noticed; and may also originate in obstruction of the ureter, disease or injury of the bladder and prostate, or stricture of the urethra.

5. *The condition of the blood.*—This is the most common of all the causes of derangement of the urinary secretion. A number of the disorders of the urine, as regards its reaction and relative composition, can be traced to dyspepsia, hepatic derangement, and defective oxygenation or metabolism; and even albumen, sugar, and bile may find their way into the urine from the same causes. One striking disorder of the urine is characterised by unnatural alkalinity and by its effects in precipitating the solid constituents. The urine is turbid from precipitation of phosphates, carbonates, and urates; and these are deposited in the passages, causing pain and irritation. If the natural acidity of the urine between meals be insufficient to dissolve these alkaline deposits, concretions are formed, and grow at each period of indigestion, until they form a *calculus*, which may travel downwards and be expelled with the urine after great suffering.

A similar disorder of the urine is characterised by excessive acidity. This has different causal relations, but the ultimate effects are practically the same—the precipitation of uric acid and urates, and possibly the formation of calculus. Excessive acidity is chiefly met with in the subjects of disorder of the liver from indulgence in proteid food (*see* page 443); and may be accompanied by an excess of urea, diminution of water, and occasionally by traces of albumen and sugar.

IV. NATURAL RECOVERY.

So many of the disorders of the urine are but expressions of derangement of the blood and of the great organic functions, that it is hardly necessary to say that natural recovery constantly occurs. Conversely, improvement in the condition of the urine is an evidence of the spontaneous return of the stomach, intestines, liver, heart, etc., to the normal state when the causes of their disorder have been removed.

The kidney possesses several provisions for natural recovery. It meets increased work by increased action; compensatory hypertrophy of one kidney occurs if the other kidney fail; and a close vicarious relation exists between the kidney and the skin and bowels. The practical therapeutist closely follows these natural methods in arranging his treatment.

V. THERAPEUTICS.

A careful consideration of the four preceding sections specially impresses two facts upon us. First, the rational treatment of any case of renal or urinary disorders must be founded upon an appreciation of the influences of other organs upon the kidneys; and, secondly, treatment may be as often directed to the kidneys for diseases of other organs as when they are themselves at fault: diuretics will be as frequently employed to relieve the heart as to stimulate the cells of the kidney.

1. (*a*) *Renal congestion from heart disease.*—This may be taken as the type of renal disorder from diminished blood-pressure, whatever its cause; and such being the pathology of the condition, the line of rational treatment is obvious. To remove the cause we must restore the normal relations of the general circulation, that is, strengthen the heart, fill and keep full the arteries, and empty the veins. How this is to be done has been already discussed in chapter x., and need not be repeated here. We are now able to estimate the value of two sets of diuretic remedies which are successfully employed in such cases, namely, the *cardio-vascular diuretics*, and the *saline diuretics*. Digitalis and Squill exactly fulfil the indications just mentioned as regards the heart, the arteries, and the veins. They increase the cardiac vigour and the period of rest; sustain the arterial tension at a moderate height; and empty the veins forwards by prolonging the diastole. At the same time, partly by these effects and partly by their local action on the renal vessels, they cause a true diuresis from the Malpighian bodies, and increase the force of the circulation through the renal veins. Ammonia, Alcohol, or Scoparium, may be combined with these drugs; and here it may be remarked, once for

all, that combination is peculiarly useful in diuretics. Saline purgatives also assist this action. Thus Sulphates of Soda and Magnesia, Acid Tartrate of Potash, Tartrate of Soda and Potash, Acetate of Potash, Citrate of Potash or Ammonia, are, in the first place, saline purgatives, thus relieving general venous congestion; and, secondly, act upon the renal epithelium, draining the over-distended venous plexus, and accelerating the circulation through the glomerulus. In other instances dilators of the renal vessels may be combined with these remedies, including Juniper and Spirit of Nitrous Ether.

(*b*) *Disorder or disease of the kidney in association with excessive blood pressure; Bright's disease with contracted kidney.*—In the early stages of this disease, when its cause may be discovered in indulgence in food and alcohol, or disorder of the liver, the treatment consists in a thorough reform of diet, free purgation, and elimination generally. Mercurial purgatives followed by salines are especially valuable. In the more advanced and grave form of high arterial tension, the cause is usually beyond our power. All that can then be done is to counteract the cause, remove its evil effects, and treat symptoms. The food should be moderate in quantity, and chiefly non-nitrogenous; stimulants must be avoided; moderate rest of body and mind insured; and various drugs administered. We are unfortunate in possessing but few medicinal means of reducing peripheral resistance for any length of time without depressing the heart; but the Iodide, Chlorate, Nitrate, and other salts of Potash, Nitrite of Soda, Belladonna, and its allies may be tried. Warmth is very essential in these cases.

2. (*a*) *Urinary derangements from nervous disorder or disease.*—The treatment employed here must be entirely directed to the nervous system. Bromide of Potassium, Valerian, and other anti-spasmodics, including moral treatment, will relieve hysterical diuresis; and Opium and Ergot are successful in many cases of polyuria of obscure and probably nervous origin.

(*b*) *Local vascular disease.*—If the emulgent veins are obstructed by abdominal enlargement, this must be immediately removed, if possible—by tapping the peritoneum, for example, or by inducing premature labour. In disease of the renal vessels we can do but little by way of direct treatment beyond relieving symptoms as they arise; regulating the flow of urine as well as possible, especially stimulating it if it threaten to become deficient; and removing the excrementitious products by the bowels and skin, when the specific gravity falls.

3. *Disease of the tubules; "Acute Desquamative Nephritis,"*

"*Large White Kidney.*"—This is the form of kidney disease in which there is the greatest or most constant danger of deficient excretion, and of the consequences of the same throughout the system. The indications for treatment are obvious. We must relieve the diseased cells of as much work as can be safely dispensed with by the blood and tissues. The rational methods of relieving the renal epithelium are: (1) by reducing the food in quality and richness; and (2) by diverting the excrementitious products to other channels. Hydragogue purgatives are especially valuable in this form of Bright's disease; and the warm air or vapour or water bath, warm drinks, and Jaborandi, will successfully relieve the kidneys by perspiration. Renal stimulants, such as the saline and specific diuretics, might, on the other hand, exhaust the cells, already weakened by disease; but in certain cases they are highly useful even in this condition, for they may exert that amount of stimulation on the renal cells which, on the principle of alteratives in general, will lead to their restoration. If we believe that the tubules are blocked by cellular and inflammatory products, we must clear them by a system of flushing, or diuresis. For this purpose Distilled Water is the best diuretic; Digitalis and Squill are also valuable, as producing but little local irritation, and tending to prevent venous congestion.

In this or in any other form of renal disease, urgent symptoms of uræmia must be quickly relieved by venesection, the administration of Chloroform, free purgation, and, if possible, profuse diaphoresis. The anæmia generally demands Iron in some form.

4. *Obstruction in the urinary passages.*—The most common cause of this serious disease, namely, stricture of the urethra, is fortunately accessible, and amenable to surgical treatment. When the obstruction is above the bladder it is very rarely bilateral, and the unaffected kidney takes on the double function of the two.

5. *Disorders of the blood, liver, and digestion; Gravel and Calculus.*—The immediate treatment of these secondary disorders of the liver, in their early stage, has been already suggested: careful low dieting, and the occasional administration of cholagogue purgatives, stomachics, and antacids. If gravel or calculus have actually formed, several other measures are still open to us, whilst the same line of treatment is persevered in to prevent further growth. We may attempt to dissolve the stone *in situ* by the continuous admistration of Citrate of Potash, or of acids, as the nature of the calculus demands, and relieve pain, hæmorrhage, mucous and purulent discharges on general principles.

SYNOPSIS OF SUBSTANCES WHICH ACT ON THE KIDNEY.

<table>
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<th colspan="4">B. MEASURES WHICH ACT UPON THE RENAL CELLS.</th>
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<th>DILATE RENAL ARTERIES.</th>
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<tr>
<td rowspan="2">Aqua Destill.
Alcohol
Digitalis (1st stage)
Scilla ,,
Convallaria
Ammonia
Scoparium (?)
Senega</td>
<td>Digitalis (2nd stage)
Scilla ,,
Alcohol
Spiritus Ætheris Nitrosi
Volatile Oils
Resins
Oleo-Resins
Balsams
Salicylates
Nitrates
Nitrites</td>
<td rowspan="2">Opium
Ergota</td>
<td>URINARY ALKALINISERS.
Potassium
Sodium
Lithium
Calcium
Magnesium</td>
<td rowspan="2">Potassæ Acetas
,, Nitras
,, Citras
,, Tartras
,, ,, Acida
,, Bicarb.
,, Carbonas
,, Sulphas
Sodæ Bicarbonas
,, Acetas
,, Citro-Tartras
Soda Tartarata
Ammonii Chloridum
Ammoniæ Acetatis Liquor
Ammoniæ Citratis Liquor
Lithiæ Carbonas
,, Citras
Lime Salts in Mineral Waters</td>
<td rowspan="2">Juniperus
Copaiba
Ol. Terebinth.
Sabina
Piper
Cubeba
Salicylates
Caffein
Uva Ursi
Pareira
Buchu
Arnica
Aconitum
Scoparium
Guaiacum
Cambogia
Cantharis
Volatile Oils
Oleo-Resins
Resins
Balsams
Jaborandi
Lobelia
Dulcamara
Alcohol</td>
<td>Iodum
Hydrargyrum</td>
<td rowspan="2">Opium
Belladonna
Hyoscyamus
Stramonium
Uva Ursi
Buchu
Pareira</td>
</tr>
<tr>
<td>RAISE GENERAL PRESSURE AND DILATE RENAL ARTERIES.
Digitalis
Scilla</td>
<td>URINARY ACIDULATORS.
Acid. Salicylic.
,, Benzoic.
,, Citric.
,, Tartaric.
Mineral Acids
TONIC DIURETICS.
Stomachics
Hæmatinics</td>
<td>RENAL DEPRESSANTS
Morphia</td>
</tr>
</table>

CHAPTER XIV.

THE BODY HEAT, AND ITS REGULATION: THE SKIN.

I. PHYSIOLOGICAL RELATIONS.

HEAT is *produced* in every act of vital energy; is *distributed* throughout the body; and is finally *lost* in the surrounding medium. In so-called "cold-blooded" animals, the vital heat is lost as rapidly as it is produced; in "warm-blooded" animals the heat produced does not escape until a certain amount has *accumulated* within the system. Thereupon loss sets in, and exactly balances the production, whilst the accumulated store remains constant, and is known as the "body heat," amounting, in man, to 98·4 degrees.

So wide is the range, so sudden are the changes, of the external temperature to which man is exposed, and so variable the amount of heat produced in the system at different moments, that in the course of its evolution the body has come to possess a complex and sensitive nervous mechanism, by which its temperature is controlled. This mechanism consists of governing centres, afferent nerves from impressionable parts, and efferent nerves to active organs. *The afferent thermal nerves*, originating in the skin, and possibly in other parts of the body, such as the mucous membranes and viscera, carry impressions of temperature (heat and cold) to the brain and cord. There these impressions are specially received by three of the great centres, viz. the *cerebrum*, where they become *sensations of temperature;* the *sweat centres* in the cord and medulla; and the *metabolic or trophic* centres, the centres of nutrition, in the brain (? pons) and cord. They also fall into the vaso-motor, cardiac, respiratory, and possibly the renal and other visceral centres. *Efferent impulses* from the sweat centres proceed to the sudoriparous glands, which they stimulate or depress, as the case may be; from the metabolic centres they are directed to the various sources of heat production—the muscles, glands, etc., which they depress or stimulate. At the same time, the circulation through the skin is modified, as well as the blood pressure generally, the respiration, renal secretion, and probably every other bodily function in some degree.

Thus, when the temperature of the air rises, the regulative mechanism comes into action, and two great effects are produced: (1) there is *increased loss of heat* by the perspiration, by cooling of the blood in the dilated cutaneous vessels, and by cooling of the blood in the lungs; and (2) there is *diminished production of heat* in the muscles, glands, etc. The same effect follows a rise of the internal temperature due to increased metabolic activity, such as muscular exercise: a "warm glow" is felt, the skin flushes and perspires, the circulation and respiration are increased, and the activity of other metabolic organs, such as the liver, is for the time lowered. The skin is the principal channel of loss of heat in man; but during and after exertion a large amount of heat must be carried off by respiration, which is familiarly known to be the chief means of refrigeration in the dog.

Conversely, if the temperature of the surface be *lowered* by cooling of the atmosphere, two reflex effects are at once produced through the nervous system, viz.: (1) *diminished loss* of heat, by contraction of the vessels of the skin, by arrest of perspiration, and by reduced activity of the circulation and lungs; and (2) *increased production* of heat in the metabolic organs, especially the muscular, digestive, and circulatory. A similar result follows lowering of the internal temperature by diminished metabolism in some of the organs. Thus Quinia and Salicylic Acid, whilst they diminish the amount of the urea and therefore probably of the heat produced in the system, make little or no impression on the temperature of a healthy man, doubtless because the channels of loss are partially closed, and the metabolism of certain organs increased, by the regulating mechanism.

II. PHARMACODYNAMICS.

1. *Temperature of the External Media.*—This is completely under our control. The atmosphere is the ordinary external medium of loss or gain of the bodily temperature, and the air of every well-constructed room or ward can be warmed or cooled at pleasure. We may select the *climate* in various ways, according to its temperature; the sub-tropics, such as Madeira, Egypt, and the Riviera, being especially valuable as affording warm climates. When a more rapid and extreme influence of the external temperature is desired, *water* may be substituted for air, in the form of baths, wet-packs, and sponging. The varieties, action, and uses of water applied in these several ways are described in the next chapter. By means of the *prolonged cold* bath, at a temperature varying between 32° and 60° Fahr., heat may be readily abstracted from the body; and the cold wet pack, cold affusion, or sponging a part or the whole of the exposed skin with cold or even tepid water, has a similar effect. These measures are known as **external refrigerants.** Heat may be *locally* abstracted by similar means, which will also have a general effect in reducing the temperature of the body. Thus, cold water may be injected into the rectum or vagina; ice or wet compresses applied to the skin; ice or cold water swallowed; or

irrigation with cold water may be used over a part. The cooling that attends evaporation is a powerful means of reducing the local temperature; and a variety of saline, spirituous, and acid solutions, such as Carbonate or Chloride of Ammonium, Spirit and Water, Brandy and Water, Vinegar and Water, or various combinations of salts, acids, and spirits, may be employed for this purpose.

2. *The Cutaneous Circulation.*—This affords us a powerful means of abstracting the body heat, inasmuch as we can modify the fulness of the vessels and the rate of flow through them. Thus we may cool the blood by dilating the cutaneous vessels by the warm bath, by Alcohol, Spirit of Nitrous Ether, or warm draughts, or by these measures combined. Opium and Chloral have the same effect. If the blood-flow be accelerated through the dilated vessels, the refrigeration is increased, and in this way cardiac stimulants of every kind, such as Alcohol and Digitalis, reduce the body temperature. Draughts of water, whether cold or hot, temporarily distend the vessels, and produce a similar effect. The opposite methods for preserving the heat of the body, by contracting the superficial vessels and reducing the activity of the cutaneous circulation, are of no therapeutical interest.

3. *The Sweat-glands: Diaphoretics, Sudorifics, Anhidrotics.*—The function of perspiration is under our control in almost every portion of its complex mechanism.

a. Measures which increase the amount of perspiration are called **diaphoretics** or **sudorifics**. The *afferent thermic nerves* in the skin can be readily stimulated by means of heat, as described in chapter xv., whether by moist heat in the form of the warm water- or vapour-bath, or various kinds of pack; by dry heat, as in the Turkish bath; or by general warmth of the air, of the room, or of the clothing. The familiar effect of Alcohol in inducing perspiration appears to be chiefly produced in the same way. *Other afferent nerves* may be used to stimulate the sweat-centres reflexly, such as those of the mouth throat, and stomach by hot spiced drinks. Perspiration may be induced by acting on the *perspiratory centre* directly. This may be accomplished by measures which increase the venosity of the blood, such as narcotics, including Opium, Chloral, Chloroform, Ether, and Alcohol in the later stages of their action; by Nicotin (Tobacco), by Pilocarpin (Jaborandi) in part; and by all measures which increase the flow of warm blood through the sweat-centres, such as hot drinks. The *efferent nerve-trunks* of perspiration may be stimulated by electricity, but this method is not therapeutically employed. The *terminations* of *the nerves* in the sweat-glands and the secreting cells can be powerfully stimulated by Pilocarpin, which causes an exceedingly profuse and rapid flow of sweat. Diaphoresis will be favoured by a free supply of blood to the glands, *i.e.* by *dilating the vessels*, as just described. A number of substances induce diaphoresis without their mode of action being clearly understood, such as—Citrate of Ammonia, and especially Acetate of Ammonia, which possibly stimulate the secreting cells, and are excreted by them along with an increased amount of water, as we see in the kidney; Antimony; some or all of the aromatic substances in a degree, especially Camphor; and several empirical remedies, viz. Serpentary, Sassafras, Sarsaparilla, Guaiacum, Mezereon, and Senega.

It will be observed that several of our powerful diaphoretics act on more than one part of the perspiratory mechanism. Thus Alcohol dilates the cutaneous vessels, increases the rate of blood-flow through the skin, and stimulates both the afferent nerves and the centres of perspiration. Warm applications to the skin and hot drinks also influence both the circulatory and the perspiratory part of the refrigerating function; and by a combination of these and other means we may produce a very powerful effect. When this is the result, and the sweat flows abundantly from the surface, the measures and result are said to be **sudorific** (*sudor*, sweat, and *facio*, I make.)

(*b*) *Measures which diminish* the amount of perspiration are called **anhidrotics** (ἀν, priv., and ἱδρῶς, sweat.) Some of these act upon the *afferent* nerves, especially moderate local cold, obtained by fanning, light clothing, and a cool atmosphere generally; and sponging with cool, tepid, or even hot water. Others depress the perspiratory *centre*—possibly in part directly, certainly indirectly by strengthening the heart and respiration, and thus reducing the venosity of the blood which powerfully stimulates it. Such are food, which is one of the best means of preventing the "cold sweats," of exhausting diseases, Alcohol, Ammonia, Strychnia, Iron, and fresh air or good ventilation. The *efferent* sweat-nerves may possibly be depressed by Opium, which in certain combinations, *e.g.* with Diluted Sulphuric Acid, is an anhidrotic, acting either in this or some unknown way. By far the most powerful anhidrotic drugs act upon the *terminations* of the perspiratory nerves in the glands, namely, Atropia and Hyoscyamia. The effect of these alkaloids or of the Extract of Belladonna is very marked. Measures which contract the blood-vessels of the glands, will *pro tanto* be anhidrotic also. Such are—sponging with solutions of Sulphuric Acid and Water, or of Tannin, which constringe the parts, and Oxide of Zinc, given internally.

Lastly, the *modus operandi* of certain anhidrotics is still doubtful, and their employment so far empirical, *e.g.* Zinc, Quinia, and Opium under particular circumstances. It is possible, however, that these and other measures control the pathological cause of the sweats, in a manner to be afterwards indicated.

4. *Other Channels of Loss of Heat.*—The kidneys and the bowels afford us a direct means of reducing the temperature of the body by the abstraction of an increased amount of warm excretions, in the form of urine and watery motions. In the case of the bowels the effect is decidedly assisted by the reflex dilatation of the cutaneous vessels which accompanies purgation, as described in chapter vi.

5. *The Heat-forming Tissues.*—In discussing metabolism in chapter ix., we found that we possess the power of diminishing tissue change, and the production of heat, by various means. Here we shall refer only to certain drugs which possess this action. We call these **antipyretics** (ἀντὶ, against, πυρετὸς, fever). The most powerful of these is Cinchona (Quinia), which interferes with metabolism generally, lessens the amount of heat produced, diminishes the excretions, and spares the organs. Salicin and Salicylic Acid, Resorcin, Chinolin, and Kairin, have a similar but less powerful action. Whilst these drugs distinctly reduce or spare the activity of the tissues, they have but little influence in reducing the temperature of healthy individuals, this effect probably being prevented by the ordinary mechanisms of regulation. Alcohol also diminishes tissue waste, apparently in a different way from Quinia, viz. by being itself decomposed in the tissues with great readiness, thus sparing the organs. Even an increased amount of heat is generated in the tissues by the oxydation of Alcohol, but so greatly does it stimulate refrigeration, as we have seen, that its total effect on the organism is antipyretic. The Aromatic substances have a less powerful influence in diminishing metabolism. Possibly, Digitalis, Aconite, and Veratria, have also an antipyretic effect, like Alcohol, but their mode of action is obscure, unless it occur entirely through the circulation, as has been already suggested.

III. PATHOLOGICAL RELATIONS.

The mechanism concerned in the regulation of the body-heat is liable to disorder, when heat-forming or heat-losing organs are diseased. Elevation of the body temperature, or *pyrexia*, most commonly called *fever*, is very rarely absent in illness of any consequence. An abnormal fall is seen as an effect of extreme cold or of exhausting diseases, but being comparatively insignificant does not require to be discussed here.

Pyrexia.—The temperature of the body may be abnormally raised in several ways. Thus we meet with excessive pyrexia in injury or disease of the *heat-centre* or *tracts*, especially injury of the cervical and dorsal regions of the spinal cord. *Exposure to excessive heat* induces "heat-fever," a variety of sunstroke which is common in India. More familiar to us is fever brought on by *interference with the refrigerating function of the skin*, as the effect of exposure to cold or damp. This is known as a "chill." A powerful impression of cold on the afferent nerves of temperature appears to throw the regulating mechanism into disorder; perspiration is arrested; the cutaneous vessels are spasmodically contracted; rigors, shivers, or chilly feelings ensue; and the heat thus retained in the blood quickly raises the temperature.

Increased production of heat at one focus, such as an inflamed part, contributes in an insignificant degree to the accompanying fever.

The increased production of heat in the tissues generally which is probably present in all kinds of fever, whatever its cause, is no doubt the principal origin of the pyrexia. The increased activity of metabolism is proved by the rapid wasting of the tissues, by the increase of urea and other excretions, and by the pyrexia as tested by the thermometer—all obvious phenomena in every case attended by fever.

In the specific fevers there is at work, however, another cause of oxydation of the tissues, which furnishes an *extraneous* addition to the body heat. We now believe that many diseases, such as typhoid fever, small-pox, and septicæmia, are associated with the presence of organisms in the tissues, if not actually caused by them. The life of such organisms, the processes of fermentation with which they are associated, and the destruction of the tissues which they produce, must all be a considerable source of heat within the body, in a way perfectly foreign to the normal processes, though closely resembling some of them.

A combination of several of the preceding causes is commonly at work in fever. Thus, when a patient has a local wound which acts as a focus of heat, the pus may decompose, *i.e.* become infected by organisms; these are absorbed into and flourish in the blood; fresh foci of disease are set up in the tissues; and the natural refrigeration of the blood is reduced by the disturbances of the skin, lungs, and circulation, which always accompany serious illness.

Disorders of Perspiration.—Only two disorders of perspiration concern us here, viz. (1) *excessive sweating*, and (2) *deficient sweating*.

1. *Excessive sweating*, *hidrosis*, *hyperidrosis*, is found in a great variety of morbid conditions. In some kinds of fever, such as rheumatism, its pathology is bound up with the pathology of the fever as a whole. In disorders of respiration, as we have seen, dyspnœal sweats are due to stimulation of the sweat-centres by venous blood. The "cold" sweats of wasting diseases such as phthisis, especially during sleep, appear to be due to the same cause, associated with anæmia and coldness of the skin, which prevent evaporation and "insensible perspiration," and thus give rise to a profuse collection of visible sweat as well as great depression of the bodily strength from interference with the cutaneous excretion. "Critical" sweats are referred to sudden changes in the disturbance of the vaso-motor system of the skin present in fever. Toxic sweating, as is seen in alcoholism and gout, may obviously be variously induced.

2. *Deficient sweating: anhidrosis.*—Dryness of the skin occurs at the beginning of most fevers, and throughout the course of most of them more or less interruptedly. It is also marked in some diseases and disorders of the urinary functions, such as Bright's disease and diabetes; in certain diseases of the skin itself; and as the result of poisoning by atropia (belladonna), etc. Manifestly different parts of the nervo-glandular apparatus are disordered in the different cases.

IV. NATURAL RECOVERY.

Disorders of the body heat being disturbances of a regulating mechanism, that is, of one means of natural recovery, we can hardly expect to find at work in fever those very provisions which have been interfered with. For the same reason, the temperature of the body generally returns to the normal on the cessation of the cause of the fever, either spontaneously or with the artificial assistance of the therapeutist. Occasionally the temperature rises beyond all control—to 107°, 110°, and even higher, and the subject dies of the effects of excessive heat or *hyperpyrexia*. In most instances of death from fever, however, the fatal result is due to one of the other factors of fever, especially the body waste.

V. THERAPEUTICS.

A great part of our knowledge of the body heat, its regulation and its disturbances, has been derived from careful observation of the results of treatment; and the use of measures to control fever—antipyretics or **febrifuges** (*febris*, fever, and *fugo*, I drive away,) is one of the most successful, as well as rational, of therapeutical proceedings.

1. *Preventive Treatment: Antiperiodics.*—The periodical return of fever may be prevented by means of **antiperiodics.** The most powerful of these is Cinchona, with its constituents, especially Quinia; Salicin, Salicylic Acid, and Chinolin, are not so powerful; less important are Nectandra and its alkaloid Beberia.

2. *Immediate treatment.*—With the abundant means at our command which we have discussed in the second section, the immediate treatment of pyrexia is very easy, inasmuch as we can lower the temperature of the surface of the body to any degree we please; for instance, by the cold bath. But we soon discover that it is one thing to reduce pyrexia, and another thing to treat fever. We can readily assist the refrigerating mechanism of the body, and we can even so far reduce the metabolic activity of the tissues, but our remedies can rarely reach the actual cause of the disorder, and the temperature rises again. As far as possible, however, we are bound to begin by discovering and attacking the causes; and if we fail in this, we must then combat the fever itself, so as to prevent its injurious effects on the system.

(*a*) *Injury or disease of the nervous system*, as a cause of pyrexia, is generally beyond treatment. If the temperature rise to a dangerous height, it must be treated by the refrigerating measures presently to be described.

(*b*) *Heat-fever* is rationally treated by immediate removal of the patient to a cool, open atmosphere, and the application of refrigeration, in the form of cold affusion.

(*c*) *Interference with the cooling function of the skin* is rationally treated by increasing the loss of heat by refrigerants. Refrigeration is practically carried out by lowering the temperature of the external medium, by increasing the cutaneous circulation, and by stimulating the secretions, by the warm bath; hot, spiced alcoholic drinks, a brisk purgative.

When fever rises high, the temperature of the room must be kept low; the skin sponged; and if the pyrexia rise to a dangerous height, the prolonged cold bath or wet pack must be employed according to the method described in chapter xiv.

Diaphoretics are chiefly employed as refrigerants in symptomatic fevers, *i.e.* in the pyrexia attending ordinary local inflammation of the lungs, bronchi, fauces, or other parts. Alcohol, Hot Water, Liquor Ammoniæ Acetatis, Ipecacuanha and Opium in the form of Dover's Powder, Antimony as the

Pulvis Antimonialis or Vinum Antimoniale, and Tincture of Aconite are the drugs chiefly used to provoke perspiration in fever. With these, the use of the warm bath may be combined.

(*d*) *A focus* of increased heat-production, such as an abscess, must be removed as soon as possible.

(*e*) *Increased metabolism generally*, which is the principal cause of pyrexia, is rationally treated by Quinia, Salicin, Alcohol, the Phenol Derivates, and Aromatic Substances. The rule commonly followed is to give a single large dose of quinia, say 10 grains, when the temperature rises above a certain point—104° or 105°, according to circumstances; or repeated moderate doses or a single large dose may be given in anticipation of the exacerbation. Ague is thus combated by Quinia, and rheumatism by Salicin or the Salicylates.

(*f*) *Foreign organisms or substances in the system.*—Fever produced by these bodies and their life-processes would be rationally treated by destroying them. We attempt to do so by administering internally some of the substances which are destructive to lowly organised life apart from the body, or in wounds on the surface of the body—the antiseptics and disinfectants, and which may be named **disinfectant antipyretics**. The value of Quinia in ague is so great, that it is referred to a specific influence upon the organism of the disease. The powerful effect of Salicin upon rheumatism has been similarly explained.

(*g*) *Combinations of causes.*—Just as fever is generally traceable to a combination of the preceding causes, so it must, as a rule, be treated by the application of remedies which act in several ways, or by a combination of antipyretic measures. Thus Alcohol will be indicated in many cases of fever, because it dilates the vessels of the skin, increases the circulation through them, and stimulates the sweat glands, whilst it spares tissue damage, and acts as an antiseptic antipyretic. Quinia will be employed with advantage when the temperature mounts high, since it controls the metabolism not only of the animal tissues, but of the septic and foreign organisms which may be wasting these. Indeed all the measures which we have analysed under the preceding heads are to be freely combined, constituting the general treatment of fever. An abundant supply of nutritious and digestible food is essential, to compensate for the great increase of metabolism which is going on. Alcohol is a true food, easily taken, rapidly assimilated, and yielding abundance of energy at little cost to the tissues, and therefore it is in general use in fevers, although it is by no means an indispensable remedy.

SYNOPSIS OF SUBSTANCES ACTING ON THE BODY HEAT.

ANTIPYRETICS.	ANTIPERIODICS.	REFRIGERANTS.	ANHIDROTICS.
Antimonium	Quinia	*Stimulants of the Cutaneous Circulation.*	Quinia
Acidum Salicyl.	Acid. Arsenios.		Belladonna
Salicin	Piper		Stramonium
Benzoinum	Eucalyptus		Hyoscyamus
Storax	? Resorcin		Alcohol, Evaporating
Camphora		Digitalis	Acids, locally in solution
Nectandra		Scilla	Ergota
Beberia		Alcohol	Picrotoxin
Piper	DIAPHORETICS.	*Dilators of Cutaneous Vessels.*	Zinci Oxidum
Quinia	Jaborandi		Acidum Sulphuricum Dilutum
Opium	Opium		Acidum Salicylicum
Arnica	Antimonium	Chloral Hydras	
Lobelia	Resorcin	Digitalis	
Alcohol	Aqua	Scilla	
Resorcin	Ipecacuanha	Alcohol	
Chinolin	Senega	Veratria	
Trimethylamin	Camphora		
Kairin	Cubeba		
Aconitum	Colchicum		
Acids	Salicin		
Eucalyptus	Acid. Salic.		
Chloral Hydras	Lobelia		
Veratria	Arnica		
Colchicum	Alcohol		
	Aconitum		
	Pot. Citras		
	Pot. Nitras		
	Am. Acet. Liq.		
	Am. Chloridum		
	Am. Cit. Liq.		

CHAPTER XV.

THERAPEUTICAL PROCESSES CONNECTED WITH THE SURFACE OF THE BODY.

THE surface of the body is of great interest and importance to the therapeutist, because it is the region of objective impressions, where influences of every kind may be brought in contact with nerves and vessels, and through them with the nervous centres, the circulation generally, and indeed the entire system. The measures applied to this part appear at first sight to be very simple, but their action is, on the contrary, extremely complex, and indeed still very obscure. On this account we have taken them last in the whole range of remedies, and it will be found that they involve all the systems already discussed, especially the nervous and circulatory. As a group they are very heterogeneous, and we will select for special consideration three distinct subjects, namely (1) *Counter-irritants*, such as blisters; (2) *Baths;* and (3) *Surgical Applications.*

I. PHYSIOLOGICAL RELATIONS.—The physiological relations of the surface of the body have already been studied under several distinct heads.

The *nerves* are connected not only with the sensorium, but with the vital centres which regulate the vessels and viscera. The cutaneous *vessels* have equally extensive relations. They have the usual nutritive function; they are the great refrigerating apparatus of the body; and they also serve as a great external blood-reservoir, in connection with the systemic circulation.

II. PHARMACODYNAMICS.—When the classes of measures given at the ends of the chapters on the circulation and nervous system are compared, it is found that several of them act on both, and that their action may be different or even opposite according to the time for which they are applied. For these and other reasons, a number of them have been collected into a special class, and called

Counter-irritants.—These measures may be thus arranged, according to the degree of their action:

1. **Rubefacients** (*rubere*, to be red, and *facere*, to make) cause increased redness and heat of the parts. Such are Hot Water; Mustard, and its preparations; Ammonia, and its preparations; the confined vapour of Chloroform, Ether, and Alcohol; all Volatile Oils, especially Turpentine, Camphor, Menthol and Thymol; Iodine carefully applied; Emplastrum Picis; and Emplastrum Calefaciens.

2. **Vesicants** (*vesica*, a blister), **Epispastics** (*ἐπι*, upon, and *σπάω*, I draw), or **Blisters**, produce a rubefacient effect, followed by the development of a blister. They include Cantharides, Mezereon, Ammonia long applied or confined, Iodine, Oil or Compound Liniment of Mustard, and Scalding Water.

3. **Pustulants** (*pus*, matter) produce a crop of pimples. They are a small group, consisting of Croton Oil, Tartar Emetic, Nitrate of Silver in strong solution, and Ipecacuanha.

Phenomena of counter-irritation.—When a counter-irritant is applied to the skin, the *first* effect is *rubefacient* and stimulant. The cutaneous vessels are dilated by a direct action on their nerves, and the local circulation becomes more free; whilst the irritation of the sensory nerves causes pain of a hot burning character. The cardiac action is accelerated, the cutaneous vessels generally reflexly contracted, the blood pressure rises, the temperature is elevated, and the breathing slowed. The highest centres are also roused by the painful impression: perception, consciousness, and the emotions are variously disturbed. Cutaneous anæsthesia follows: the nerves are depressed, pain is relieved, excepting that caused by the application itself.

Prolonged application is generally required to induce the *second* degree of counter-irritation—*vesication.* The reddened area now becomes inflamed; plasma escapes from the vessels, followed by corpuscles; the epidermis is raised, and a vesicle is formed containing a quantity of fluid. The previous anæsthesia is now replaced by considerable local pain, which, if extensive, may depress the viscera—weakening and slowing the heart, lowering the pulse, further slowing the respiration, lowering the temperature and diminishing nervous energy.

The *third* degree of counter-irritation, *pustulation,* is different in kind from vesication as well as more severe, the result being not uniform inflammation, but a crop of painful, "angry" pimples or pustules, which are very slow to heal. The remote effects are the same as before, but greater.

Theory of the action of counter-irritation.—Such are the phenomena of this method, obvious to all. But it is held by some that not only the functional activity, but the *nutrition* of internal parts may be affected by means of it. The doctrine of counter-irritation may be said to be, that when a part at some distance beneath the surface of the body, such as a joint, or even remote from it, such as the lungs, is in a condition of inflammation, pain, unnatural activity, or overgrowth, an alterative effect may be produced upon its nutrition, by altering the condition of an area of skin superficial to it, or even at a distance from it. A second or "counter" seat of "irritation" is set up to relieve the deeper and more vital part. Now we may conclude with respect to this theory:

1. That rubefacients and vesicants will afford relief to the circulation of parts in immediate vascular connection with the selected area, by attracting blood and draining off plasma; to the same extent the general circulation will be depressed, and visceral congestion or inflammation will be diminished. At the same time the heart will be relieved.

2. That the irritation of the cutaneous nerves will modify in a simple reflex way, through the centres in the brain and cord, the circulation and nutrition generally, of the parts beneath; the impression which passes in being immediately reflected along the vascular or trophic nerves.

3. That possibly the irritation of the local nerves and vessels may affect the vaso-motor and trophic centres in the brain and cord, presiding over the area of skin; and that this disturbance may so influence a neighbouring trophic centre (say of a joint) as to produce through it a change in the nutrition of the tissues (such as a joint) in the neighbourhood of the area to which the irritant was applied.

4. That vesicants and pustulants may produce a flow of plasma or pus, which will relieve the blood or tissues of organised or other poisons, which are the cause of the disease. This is the old humoral view, founded on the pathology that "humours of the blood" are the origin of disease.

III. PATHOLOGICAL RELATIONS AND THERAPEUTICS.—The pathological conditions which we seek to influence by counter-irritants belong to various systems, which have been already discussed. The same remark holds true of the therapeutical applications of the principles just examined. All that remains to be done here is to enumerate the chief morbid conditions which may be treated by counter-irritation. These are, (1) Subacute or chronic inflammation, with or without unnatural growth, of parts in direct vascular connection with the skin; *e.g.* of a joint or bone. (2) Congestion or inflammation in neighbouring viscera; *e.g.* of the lungs. (3) Pain in deep or distant parts, such as neuralgic, cardiac, or renal pain. (4) Spasm, or other morbid activity in deep muscular structures, such as lumbago and vomiting. (5) Central nervous disturbances such as syncope and hysteria.

Baths and Allied Measures.—The principles on which the use of baths depend are in a great measure identical with those which we have already discussed, and do not require to be repeated. If the student will carefully bear in mind the relations of the vessels and nerves of the skin to the body heat, circulation generally, and nervous system, he will readily appreciate the subject of baths from the following tables, which give a list of the most common baths, together with their action and principal uses succinctly arranged.

I. WATER BATHS.

Name.	Temperature.	Action.	Uses.
Cold.	32° to 60°	Cools blood in cutaneous vessels; stimulates heart, respiration, etc., reflexly. Temporarily overfills internal vessels, thus raising blood pressure.	Refrigerant in fever. Refreshing: The morning bath.
Cool.	60° ,, 70°	The same, but less marked.	The same in weaker subjects.
Tepid.	85° ,, 95°	Detergent (cleansing), physically and chemically; soothes the nerves.	Ordinary personal cleanliness. Allays restlessness of fever and lowers temperature.
Warm.	95° ,, 100°	Raises local temperature; stimulates local circulation; stimulates glands, increasing discharge of warm secretions, and evaporation; soothes the nerves and the corresponding centres.	Diaphoretic in fever; diaphoretic in uræmia; anodyne; antispasmodic.
Hot.	100° ,, 106°	The same, but more marked.	The same, but is more powerful.
,, Local.	,, ,,	Attracts blood *to* part bathed.	To stimulate menstrual flow.
,, ,,	,, ,,	Attracts blood *from* distant parts.	To relieve internal congestions, as in catarrh and apoplexy.

II. VAPOUR BATHS.

Name.	Temperature.	Action.	Uses.
Simple Vapour or Russian.	95 to 110°	Much like the warm or hot bath, but slower, and at higher temperature.	Much like the warm bath. A powerful diaphoretic.
Medicated watery Vapour.	,, ,,	The action chiefly of aromatics.	Stimulant and antispasmodic.
Fumigations.	Various.	Specific (Mercury, Sulphur, etc.).	Specific.

III. AIR BATHS.

Name.	Temperature.	Action.	Uses.
Hot air, or Turkish.	Up to 220°, followed by cold.	Diaphoretic, followed by stimulation; anodyne; increases metabolism.	Like warm water and Russian baths. Tonic.
Compressed air.	Ordinary.	Increases oxygenation.	Diseases of the lungs and heart.

IV. MEDICATED BATHS.

Name.	Temperature.	Action.	Uses.
Natural.	That of the spring.	Specific.	Gout, rheumatism, syphilis, skin diseases, etc.
Sea.	Various.	Stimulant.	Invigorating.
Artificial.	Various.	Specific, *e.g.* Nitro-hydrochloric Acid, Sulphide of Potassium, and Mercurial solutions.	As alterative in hepatic disease, rheumatism, syphilis, plumbism, scabies, and other skin diseases.

V. COMPLEX BATHS.

Name.	Temperature.	Action.	Uses.
Mercurial and vapour.	Sufficient to vaporise water and mercurial.	Specific.	Syphilis.
Mercurial and hot air.	Sufficient to vaporise mercurial.	Specific.	Syphilis.
Mud, pine, bran, etc.		Various.	Various.

The cold bath in fever.—A simple tepid water bath is prepared, at a temperature of about 90°; the patient is carefully placed in it; and cold water is added until the thermometer falls to 80° or even 40°, according to circumstances. Here the patient remains for 10 to 20 minutes, his temperature being taken during immersion, or if any shivering occurs, he is at once removed. He is then wiped dry, placed in bed, and covered with blankets. A stimulant may be required. The cold bath may be repeated several times a day, if indicated.

In very urgent or desperate cases the cold bath may be increased in activity by lowering the temperature to freezing point by ice, and by prolonged immersion, even to three hours. This treatment requires great care and judgment.

The douche, affusion, and shower bath. — The stimulant action of water may be greatly increased by directing it against the body in a single or divided stream. The size, height, direction, and temperature of the stream, the part and extent of surface to which it is applied, have great influence upon the effect of the douche. The *uses* of the shower bath are chiefly in hysteria and mania; of the local douche in loss of sensibility of parts, chronic enlargements of joints or bones, and sprains. Affusion is of value in convulsions, sunstroke, mania, hysteria, and as a means of resuscitation.

The Wet Pack.—Prepare a bed by spreading two blankets on the mattress and over the pillow of an ordinary single bedstead. Thoroughly wet a linen sheet with cold water, and spread it smooth over the blankets. Strip the patient, place him flat on his back on the wet sheet with his head on the pillow, and envelop him in the sheet and blankets, by bringing these one side at a time across his body, and tucking them under the opposite side and under the heels. Finally cover him with several more blankets, and again tuck these closely round him. The ordinary duration of packing is a quarter of an hour to an hour. The pack is then removed, and the skin rubbed with a dry towel. The pack may be repeated several times a day if necessary.

The first sense of chilliness produced by the wet sheet is quickly replaced by a delightful glow. The physiological action of the wet pack is chiefly on the refrigerating function of the skin: heat is abstracted so that the temperature quickly falls; the frequency and force of the pulse decline; the central nervous system is soothed both through the nerves and through the circulation, and by the refrigeration; sensibility, pain, irritability, and delirium, are dispelled; and sleep often follows immediately.

The *use* of the wet pack is almost confined to the specific fevers, such as scarlatina and typhoid, when the pyrexia is excessive, delirium high, and the rash ill-developed.

The Treatment of Wounds.

1. **Antiseptics** prevent putrefaction in a wound by virtue of their action in arresting the growth of organisms, or destroying these or the chemical activity of certain substances which give rise to fermentation and decomposition. They include: Carbolic Acid, Creasote, Boracic Acid, Iodoform, Iodine, Eucalyptus, Thymol, Salicylic Acid, Quinia, Sulphurous Acid, Perchloride of Mercury, Chloride of Zinc, Alcohol, Permanganate of Potash, Turpentine, Benzoin, Balsam of Tolu, and Balsam of Peru.

2. **Disinfectants** are substances which destroy micro-organisms, or active chemical substances and their products, on surfaces already foul or infected. They are for the most part the same materials as the antiseptics, but are employed in a much stronger form. Such are strong solutions of Chloride of Zinc and Carbolic Acid, Iodoform, Iodine, Sulphurous Acid.

3. **Deodorants** absorb gases and neutralise foul odours. Those chiefly used are Charcoal, Permanganate of Potash, and Iodoform.

4. **Astringents** coagulate or precipitate the albuminous discharges, coagulate the germinal protoplasm of the upper layers of cells, and either directly contract or indirectly constringe the vessels, so as to limit exudation. They are used to check excessive discharge and granulation growth; and thus give tone to wounds. Astringents include: Solutions of Nitrate of Silver, Subacetate and Acetate of Lead, Sulphate of Zinc, Sulphate of Copper, Alum, Persalts of Iron, Tannic Acid and its allies, and Carbolic Acid.

5. **Stimulants** are for the most part mild astringents, applied chiefly in the form of lotion; such as weak solutions of Nitrate of Silver, Sulphate of Copper, Sulphate of Zinc, Carbolic Acid, etc. They are more efficacious as weak spirituous solutions. Stimulants are used to wounds when healing flags or the granulations tend to become prominent.

6. **Styptics** are applied to wounds to check hæmorrhage. They include: Ice, Persalts of Iron, Nitrate of Silver, Matico, Tannic acid.

7. **Caustics and Escharotics** are intended to destroy part

of the living tissues, and thus destroy or arrest the activity of organic poisons, as in bites, dissection wounds, syphilis, malignant disease, and gangrenous processes. They include: Caustic Alkalies, Mineral Acids, Solution of Chloride of Antimony, Chloride of Zinc, Nitrate of Silver, Sulphate of Copper, Arsenic, Acid Nitrate of Mercury, and Dried Alum.

8. **Vesicants** are applied to chronic ulcerating surfaces to stimulate the circulation in the surrounding parts, and soften callous edges. Cantharides is chiefly used.

9. **Anodynes** are intended to alleviate the pain of wounds and ulcers, and induce sleep. The medicinal anodynes commonly thus applied are preparations of Opium and Belladonna.

APPENDIX.

SUBSTANCES WHICH ACT ON THE PUPIL.

PUPIL DILATORS : MYDRIATICS.	PUPIL CONTRACTORS : MYOTICS.
Belladonna	Physostigma
Atropia	Eserin
Stramonium	Jaborandi
Hyoscyamus	Pilocarpin
Hyoscyamia	Opium
Duboisia	Morphia
Homatropin	
Gelsemium	

SUBSTANCES WHICH ACT UPON THE GENERATIVE ORGANS.

SUBSTANCES WHICH STIMULATE THE NON-GRAVID UTERUS : EMMENAGOGUES.	SUBSTANCES WHICH STIMULATE THE GRAVID UTERUS : ECBOLICS : OXYTOCICS.	SUBSTANCES WHICH DEPRESS THE UTERUS.
Myrrha	Ergota	Bromides
Aloes	Sabina	Opium
Ergota	Ruta	Chloral Hydras
Sabina	Pilocarpin	Cannabis Indica
Ruta	Drastic Purgatives	Chloroformum
Alcohol		Antimonium Tartaratum
Cantharis		Tabacum
Digitalis		Cupri Sulphas
Actæa Racemosa		Emetics
Purgatives		
Hematinics		
Tonics		

SUBSTANCES WHICH STIMULATE THE SEXUAL ORGANS : APHRODISIACS.	SUBSTANCES WHICH DEPRESS THE SEXUAL ORGANS : ANAPHRODISIACS.
Camphora (at first)	Bromides
Opium ,,	Camphora (at last)
Cannabis Indica	Opium ,,
Nux Vomica	Tabacum
Strychnia	Belladonna
Phosphorus	Hyoscyamus
Cantharis	Stramonium
Alcohol	Circulatory Depressants
Lupulus	
Hæmatinics	
Tonics	

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